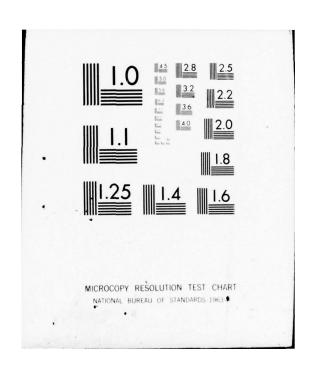
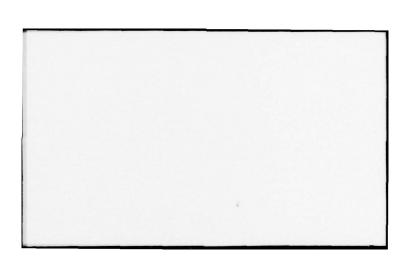
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UNCLASSIFIED SECURITY CLASSIFICATION OF THIS PAGE (When Dat) Entered) READ INSTRUCTIONS BEFORE COMPLETING FORM REPORT DOCUMENTATION PAGE 2. GOVT ACCESSION EPORT NUMBI THE INVENTORY SYSTEM SIMULATOR, (INSSIM) VOLUME MODEL DESCRIPTION INTERIM SMING ORG. REPORT NUMBER GRANT NUMBER(S) AUTHOR(s W. Steven Demmy F4962**9**-77-C-ØØ63 PERFORMING ORGANIZATION NAME AND ADDRESS Decision Systems 3575 Charlene Drive Dayton, OH 45432 11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Office of Scientific Research/NM August Bolling AFB, DC 20332 14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) UNCLASSIFIED 15a. DECLASSIFICATION DOWNGRADING SCHEDULE 16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited. A046053 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) 18. SUPPLEMENTARY NOTES 19. KEY WORDS (Continue on reverse side if necessary and identify by block number) single-location, multi-item, EOQ, inventory, simulation model, FORTRAN 20. ABST ACT (Continue on reverse side if necessary and identify by block number) This report describes the features of the Inventory System Simulator (INSSIM), a FORTRAN-based simulation model of a general single-location inventory system. The model was specifically designed to evaluate alternate forecasting and inventory mamagement policies proposed for use in

the EOQ Buy Computation System (1062). Volume I of this report describes the philosophy, organization, and input/output features of INSSIM. Volume II documents the FORTRAN statement listings of each INSSIM program, and provides

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THE INVENTORY SYSTEM SIMULATOR,

(INSSIM)

VOLUME I: MCDEL DESCRIPTION

Approved for public release; distribution unlimited.

by

W. Steven Demmy

August 1977

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CHAPTER I

INTRODUCTION

This is the first of two volumes describing the features of the Inventory System Simulator (INSSIM). INSSIM is a FORTRAN-based model of a general single-echelon inventory system. The model was specifically designed to evaluate alternate forecasting and inventory management policies proposed for use in the EOQ Buy Computation System (D062). This volume describes the philosophy, organization, input/output features, and Job Control streams associated with INSSIM. Volume II documents the FORTRAN statement listings of each INSSIM routine, and provides narratives describing the function of each of these routines.

Chapter II of this report describes the major features of the EO2 Buy Computation System. This system is the primary data system for the control of stock fund items managed by the Air Force Logistics Command. In general, D062 manages discrete components that are part of the higher assembly and are not economically reparable at the depot level of supply. Major inputs to the D062 system and major management concepts used for the management of these items are described in this chapter.

Chapter III provides an overview of the INSSIM model.

This chapter outlines the major features of the simulation,
and discusses the major output products produced by the model.

Chapter IV reviews major concepts employed in the Inventory System Simulator. The chapter defines timing mechanism employed by the simulation, the major events that are simulated within the model, and the subroutines and data files that are required to perform the associated bookkeeping functions. Most of the major INSSIM variables are defined in this chapter.

Chapter V discusses the operations of the MAIN program.

This program is the workhorse of the simulation. This routine is responsible for the control of input data, initialization of status and performance variables, the scheduling of simulation events, and the control of output products. Flow charts and a detailed discussion of this routine is presented in Chapter V.

An important feature of the INSSIM model is the capability to simulate inventory demand patterns so as to exactly duplicate the demand patterns recorded in D062 history files. Chapter VI describes the demand generation process by which this is accomplished.

To users, the most important feature of any model is its input requirements and the associated output products. These are the topics of Chapters VII and VIII. Input requirements for the model are discussed in detail in Chapter VII while output products are discussed in the following chapter.

The Job Control Language programs which are used to initiate INSSIM job streams are discussed in Chapter IX. This chapter discusses three sets of job streams. One job stream is particularly useful in the debugging of INSSIM enhancements, while the other two job streams are useful for the initial testing of a new data set, and for the conduct of production runs involving large numbers of items.

Finally, details of input/output records and job control language listings are provided in the appendices.

CHAPTER II. The EOQ Buy Computation System

The EOQ Buy Computation System (D062) is the primary data system for the control of stock fund items managed by the Air Force Logistics Command. In general, this system manages discrete components that are part of a higher assembly and are not economically reparable at the depot level of supply. The terms "repair parts," "bits and pieces," "consumable items," "stock fund items," and "expense items" are often used to describe these parts. AFLC manages approximately 500,000 of these items.

The primary functions of the EOQ Buy Computation System are to:

- a. Accumulate demand data.
- b. Compute depot stock levels.
- c. Determine buy, termination, and long supply quantities.
 - d. Provide a baseline for funds projections.
 - e. Provide reports and management data.

As illustrated in Figure II-1, inputs to D062 come from several sources. Headquarters AFLC specifies the implied shortage factor (λ) required by the Presutti-Trepp safety stock formula. Stock list data, asset and usage counts, and file maintenance actions are other inputs to the D062 system.

11-2

Figure II-1. Inputs to the Requirements Process

Note: The HOSI and DIM ROHIS inputs are not complemented at present.

This information is used to compute several critical numbers, called "levels," that are used to initiate management notices on a by exception basis. For example, currently available assets are compared to the levels to determine if buy, termination, or disposal actions are needed.

Figure II-2 illustrates the major outputs of the D062 System. These include:

- a. Requirements Notices -- The item manager receives advance buy, buy, or termination notices when assets breach the respective levels. Item interrogations can also be requested by the item manager.
- b. Management Reports -- These data products are produced for the Air Logistics Centers and Headquarters AFLC summarizing the impact of the computation by categorizing items according to actions required.
- c. CSIS Data -- Data required to perform the Central Secondary Item Stratifaction is passed to the D075 system every quarter.
- d. Data to Other Interfacing Systems -- D062 also provides information to the D067 and D032 systems. D067 is furnished data required to process excesses, and D032 is fed control levels required for distribution of assets.

Control Levels

In the D062 system, the terms "asset position" and "inventory position" refer to the total assets on hand and on order in the system, less any backorders.

Hence, an item's asset position is the total stock available to meet future demands if there are no more buys.

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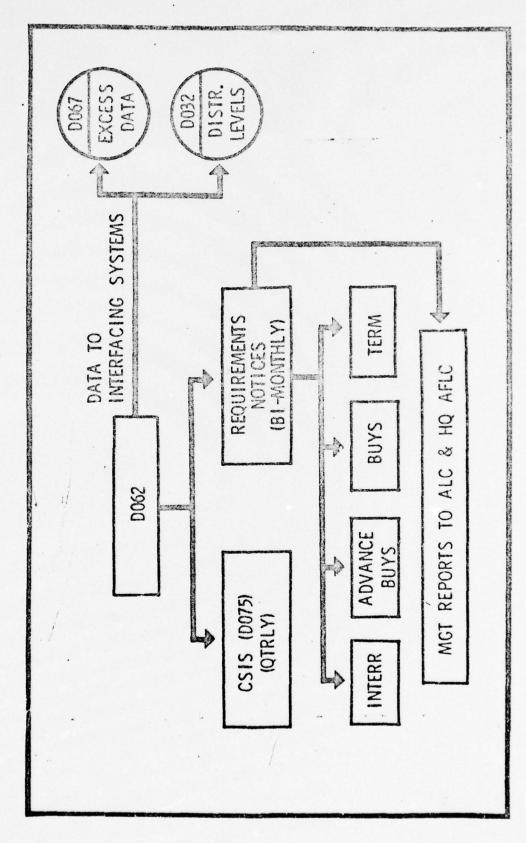


Figure II -2. Outputs from the EOQ Buy Computation System

As noted above, D062 computes various "levels" which are compared against an item's asset position to determine if any action is required. These levels are summarized in Figures II-3 and II-4. Procurement lead time is the average time that elapses from the first printout of a buy notice to the date of the first significant delivery. The safety level is variable depending on item characteristics and HΩ AFLC inputs. Its purpose is to insure continuous operation in the event of unpredicted fluctuation in demand and/or extended lead times.

The reorder level (ROL) equals the number of demands expected in the procurement lead time plus the safety level. It is the point to which available assets are compared to determine if a buy action is required. When an item's inventory position equals or falls below the reorder level, the buy quantity consists of any deficiency to the reorder level plus an economic order quantity.

The data level represents four months of demands beyond the reorder level. The function of the data level is to provide early identification of items in a potential buy position.

The termination level is one years worth of demands beyond the ROL. Note: If EOQ > one year's supply, the termination level = ROL + EOQ. Termination level notices

7

PROCUREMENT LEAD TIME (PLT)

. TIME FROM PREPARATION OF PR/MIPR TO DATE OF FIRST SIGNIFICANT DELIVERY

SAFETY LEVEL

AMATERIEL AUTHORIZED TO BE ON HAND TO INSURE CONTINUOUS
 OPERATION IN THE EVENT OF UNPREDICTED FLUCTUATION IN
 DEMANDS AND / OR EXTENDED LEAD TIME

REORDER LEVEL

COMPUTED POINT TO WHICH ASSETS ARE COMPARED TO DETERMINE IF
 BUY ACTION IS REQUIRED

DATA LEVEL

 PROVIDES EARLY IDENTIFICATION OF ITEMS IN A POTENTIAL BUY POSITION

TERMINATION LEVEL (TL)

● USED TO DETERMINE THOSE ITEMS WHICH ARE CANDIDATES FOR CONTRACT TERMINATION

APPROVED FORCE ACQUISITION OBJECTIVE (AFAO)

- DETERMINES BEGINNING OF ECONOMIC RETENTION
 - · USED AS STOCK FUND CREDIT INDICATOR

RETENTION LEVEL

• INDICATES MAXIMUM LEVEL OF STOCKS WHICH MAY BE RETAINED IN SUPPLY SYSTEM, (CONSISTS OF AFAO I - 5 YEAR'S REQMTS.)

PROJECTED NET BUY

• ROL DEFICIENCY + EOQ

are output for items with on order assets when the total asset position is greater than the termination level. This notice warns the item manager that it may be desirable to cancel delivery of at least part of the on order quantities. The approved force acquisition objective (AFAO) consists of two years worth of forecast demands plus the lead time and safety level requirements. (Note: If EOQ > 2 years of supply, AFAO = EOQ + ROL.) Items with assets greater than the AFAO are considered to be in long supply.

Finally, the retention level indicates the maximum amount of stock which may be retained in the supply system. Generally, quantities beyond this value are considered excess. Retention levels can vary from one to five years of projected demands beyond the AFAO. Retention levels for items supporting never weapon systems generally use five years, while systems ready to be phased out may have retention levels equal to the AFAO plus one year of projected demands.

Formulas

A basic problem in any inventory system is determining how much stock should be on hand. If too much stock is procured, excessive carrying costs are incurred. On the other hand, if too little stock is procured, an item must be procured more often, and excessive procurement costs are incurred. In the D062 system, the Wilson lot size formula is used to obtain a good balance between these conflicting costs. This formula takes the form:

$$Q = \sqrt{\frac{2AD}{H}}$$

where Q equals the order quantity in units, D is the annual demand rate in units, A is the cost per order placed, and H is the cost of holding one unit in inventory for one year. At present, a holding cost H of 20% of the item unit cost per year is used in the lot size formula.

In Air Force supply systems, different procurement methods are employed for small purchases than are used for high dollar buys. Simplified procurement techniques are used for small dollar purchases. These methods may be used for purchases of less than \$10,000. On the other hand, advertized, negotiated contracts are used for high dollar buys. At present, the following order costs are used in the D062 system:

COST TO ORDER

\$269.87 for purchases of less than \$10,000 \$460.27 otherwise

In applying the EOQ formula above, impractical values for order quantities are produced for items with very high

or with very low annual demand rates. Consequently, EOQ's are bounded to be no more than a 36 month supply, and no less than a 6 month supply.

At present, safety levels are computed in D062 using the Presutti-Trepp formula with $Z = \sqrt{R}$. This quantity is then bounded to be no more than (a) the number of demands expected in the procurement lead time or (b) three times the standard deviation of lead time demand, whichever is smaller.

Figure II-5 illustrates the levels computations for a particular, fast moving item. This item has a unit price of \$10, a procurement lead time of nine months, and an average of 100 demands per month. The expected demand in the nine month procurement lead time is thus 9 X 100 = 900 units. The safety level for this particular item is 113. This was determined based on the PT-safety level formula. The reorder level is the sum of the safety level and the expected demand in the procurement lead time, which gives us 113 + 900 = 1013. The data level is four months worth of demands beyond the reorder level. This item has annual demands D of 1200 units per year, and the cost of holding one unit in inventory for one year is 20% X unit price = \$2 per year. Hence, the EOQ is $\sqrt{2AD/H} = \sqrt{2} \times (\$269) \times$ (1200)/\$2, or 568 units. A cost per order of \$269 is used in this calculation since the dollar value of the purchase

	AFAO + 5 YRS	ROL + 2 YR	$\sqrt{2 \text{ AD}}$ (5.6 MOS)	ROL + 4 MOS	SI + PLT	VARIABLE	9 X MONTHLY DEMAND		
	RETENTION LEVEL	AFAO (TERMINATION LEVEL)	EOQ	DATA LEVEL	REORDER LEVEL	SAFETY LEVEL	PROGUREMENT LEAD TIME	ITEM DATA	UNIT PRICE \$10
0 .	9413	3413	568	1413	1013	113.	006		

Figure II-5. Levels Computation

AV MOS DEMANDS 100

PLT 9 MOS

is \$10 X 568 = \$5,680. Since this is less than \$10,000, small purchase methods may be used. The AFAO is two years of stock beyond the ROL and the retention level is five years worth of demands beyond the AFAO.

CHAPTER III. INSSIM - The Inventory System Simulator

As noted above, a detailed simulation model of the D062 system was needed to evaluate the relative effectiveness of the alternate PT-formulas. In our study, we utilized the Inventory System Simulator (INSSIM) as a starting point. This simulator was developed by the Directorate of Management Sciences (AFLC/XRS) to evaluate inventory policies in single location supply systems. For our study, it was necessary to enhance the original model to provide a detailed description of the current D062 system and to provide for improved input and output capabilities. In the following discussions, we will use the term "INSSIM" to refer to the enhanced version of the original simulator.

Major Features of the Inventory System Simulator (INSSIM)

The Inventory System Simulator (as enhanced) possesses the following major characteristics:

- a. A detailed description of the EOQ Buy Computation System (D062).
- b. A demand process based upon actual demand histories for Air Force items.
- c. Comprehensive measurement of simulation results.
- d. Entensive input options -- which permit the evaluation of several proposed forecasting and inventory control policies by simple changes to input data.
- e. A modular structure -- to simplify future enhancements to the model.

f. Debugging aids -- to assist in the programming of proposed rules that are not already coded in the model.

Basically, INSSIM consists of a collection of Fortran subroutines and a MAIN program that controls input requirements, schedules events within the simulation, and initiates output products. The major INSSIM routines are illustrated in Figure III-1, grouped by their major function. As shown in the figure, the major features of the D062 system are simulated using subroutines FOR576, FORUPD, LEVEL, and STATUS. The major functions of these routines are as follows:

Subroutine	Function	Description
FOR576	Forecasting	This routine provides estimates of
		 gross demand rates serviceable return rates net demand rates average requisition size demand variability
FORUPD	Record demand history	This routine maintains an eight quarter moving history of simulated demand. This history is used in the forecasting calculations in FOR576.
LEVEL	Computes inventory control levels	This routine computes the inventory control levels discussed above (safety levels, reorder levels, etc.)

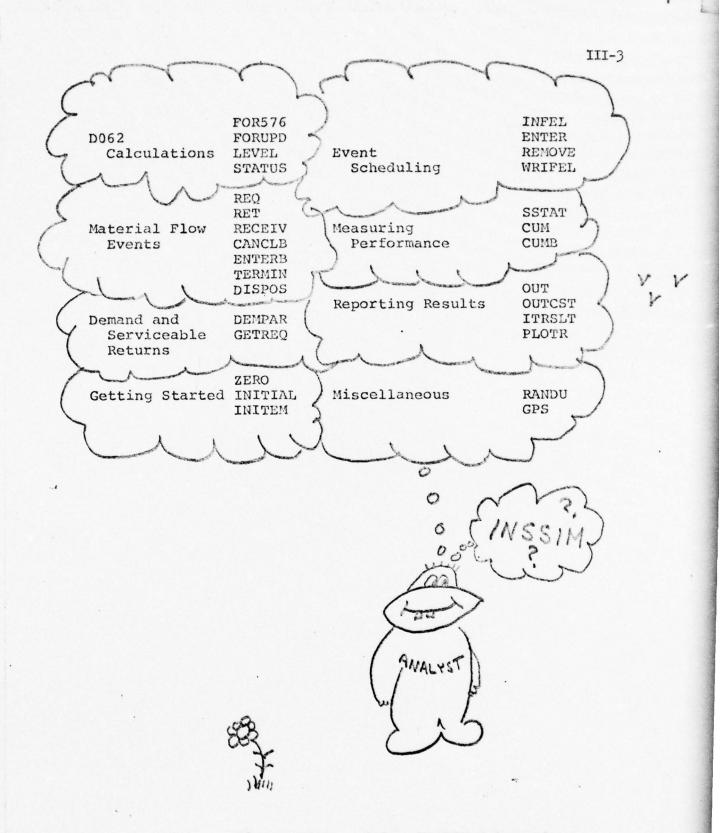


Figure III-1. Major INSSIM Subroutines

Subroutine	Function	Description
STATUS	Compares available assets to the respective control levels, and initiates appropriate actions	This routine simulates the management action portion of D062 system.

Each of the above routines contain logic describing the computational formulas and management policies currently used in the D062 system. In addition, these routines also possess logic describing several forecasting and inventory control procedures that have been suggested as alternatives to current methods. These alternate procedures may be simulated by changing one of the eight parameter cards that specify the characteristics of a given simulation run. Hence, a number of alternate inventory management proposals may be evaluated by simply changing the input specifications to INSSIM.

In addition to the D062-related subroutines described above, several other INSSIM routines are used to describe significant events in the flows of EOQ items. These events and their corresponding subroutines are as follows:

Routine	Event
REQ	A requisition is received at the depot. This represents a demand for a specific number of units of a particular EOQ item. If possible, the requisition is filled immediately; otherwise, the requisition is backordered until a replenishment order is received.
RET	A number of serviceable units are returned to the supply system.
RECEIV	A replenishment order is received by the supply system.
CANCLB	A customer with an outstanding backorder cancels the requisition.
ENTERB	Record the current requisition as a back- order, and insert it into the backorder file.
TERMIN	Action is taken to stop a replenishment order that has not yet been received. This event is initiated whenever an item's asset position exceeds the termination level, and a replenishment order is still being processed.
DISPOS	Assets in long supply are disposed of.

(Note: The routines CANCLB, TERMIN, and DISPOS were not used in the current study.)

Each of the above routines perform bookkeeping operations that update the status of on hand and on order stocks. These routines also post activity statistics that record inventory system performance.

The methods for describing the demand generation process is a critical element in any inventory simulation. In INSSIM, the demand generation process is derived from demand

and serviceable return histories for actual Air Force items.

Specific computational details are handled by subroutines

DEMPAR and GETREO.

As we shall see below, a major input to our study is the actual demand histories for a sample of EOQ items from the EOQ data bank. This input defines the actual quarterly demands and serviceable returns for each item for the period FY 71 through FY 76, a total of 20 quarters worth of data. In our study, the first eight quarters of data were used to initialize the history files needed in the D062 usage rate calculations. The remaining 12 quarters of data were used to simulate demands in the inventory system.

The demand generation process is constructed so that within a particular quarter, the number of units of demand and the number of serviceable returns simulated exactly equals the actual values from the EOQ data bank. Within a given quarter, specific requisitions are generated that have the same statistical characteristics as current USAF items. Specifically, requisition sizes are generated according to the probability distributions presented in Figure II-2 of reference 2.

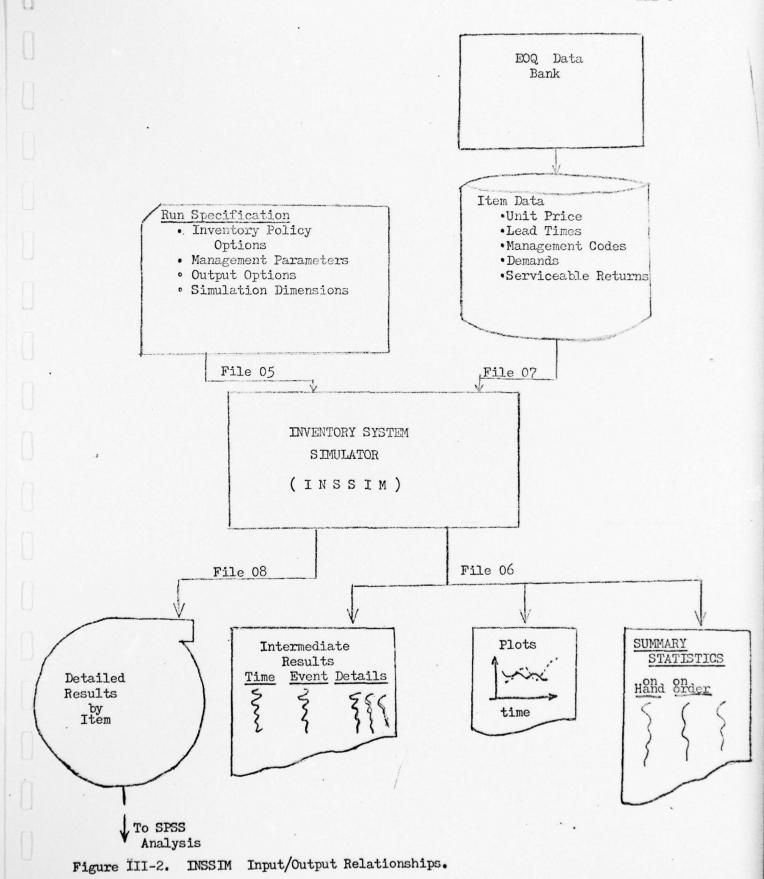
As shown in Figure III-1, a number of other routines are also used in INSSIM. These routines are required to initialize the simulation model, to collect and summarize

performance statistics, and to assist in event scheduling and other bookkeeping tasks. Rather than discuss these routines individually, the following sections describe the ultimate results of these routines upon INSSIM input requirements and output products.

INSSIM Inputs and Outputs

Figure III-2 illustrates the major data flows of the Inventory System Simulator. Run specifications are input from File 05 in card format. This input specifies the inventory policy options that are to be simulated in the current run, as well as significant parameters (e.g., holding cost, ordering costs, and bounds on EOQ's and safety stocks) required by these policies. Other input cards specify the output options to be employed, and the size of the simulation run (e.g., number of items to be simulated, time duration for the study, etc.). A print-back of the run specifications for a 100 item, 12 quarter simulation run is shown in Figure III-3. (A detailed discussion of variables shown in this figure is presented in Chapter VII.)

As shown in Figure III-2, item demand and cost data is input through File 07. This file provides item information extracted from the EOQ Data Bank. This file contains data



INVENTORY SYSTEM STAGGATOR			
SUN PAPAMETERS	(CS) MANAGEMENT METHODS TO BE	USED	
(C1) RUN-10. 3 TITLE. 100 ITEM SIMULATION WITH Z	FRO SS 1CPFOR FOREGAS	FOREGAST FORMULA = 1	
		FORMULA = 1	•
(C2) OUTPUT CONTROLS(NOTE. 1=YFS)	ICBEOG EOO	FORMULA = 2	
ITURI IT. URITE: 0	TOBSI. SAFETY	STK CUDE = 3	
1001 SIIPMAPY = 1	ICUSTE SAFETY LIMIT	LIMIT CODE = 1	
IGRAPH GRAPHS = 1	TGP86 RUBGET	GUIPE GUDE = 1	
IPUNCH PIINCH = 1	ICDSP RETURNS CORE	CONF = 1	
	and the same of th		
(C3) DEHUG FLAGS	(CG) MANAGEMENT PAPAWETEPS	METERS	
0 = 01841	FOUNTN MIN END (MNTHS)	(MNIHS) 6.0000	
1584G = 1	FOOMAX MAX EOG	EDD(MATHS) 36,0000	
1FH16 = 0	SLMIN . MIN SAF	SAFETY LV(MNTHS) 0.	
10816 = 0	SLMAX MAX SAF	SAFETY LV(MNTHS) 0.	
	(C7) SYSTEM PARAMETERS	Sa	
ISTRAC STOP TPACE AT 0 FOR ITEM 1	ENTO IOH O HOLD HOLD	HOLDING COST/5-1NV 0.2009	
(C4) ITEM INPUT FILES	TROO BOYLAUNS. LAONSO	E COST 10.0000 31.6000	100.000
INLU FILE = 7 (1 = RCD: 2 = RINARY)	CUSORB(1) SMALL DROFER	90FR COST 269.8700	
UTRS = 24	CUSORD(2) LAPRE OF	0.811ER COST 460.2700	
	CSTBRK CAST BR	COST BREAK-POINT 10000.0000.	
	(GR) SIMULATION SIZE		
	AN MINN NIINN NIINN	of Puns	
	THOTP NUMBER OF	OF UNARTERS 12	

Figure III-3. Specifications for a 100 Item 12 Quarter Simulation Run,

100

MO. UF BEPLICATIONS MO. OF ITEMS/REPL

MITTER

NAEPI

defining the unit price, lead times, management codes, demands and serviceable returns associated with each item to be simulated.

Output products produced by INSSIM are routed to files 06 and 08. File 08 is a magnetic tape file. It contains details by quarter on the performance of each item simulated. This file is designed for subsequent statistical analysis of the simulation results using the SPSS Statistical Package.

File 06 is routed to the printer. If all output options are requested, this file will contain a print-back of all input data, an event-by-event description of the simulation process, and detailed plots and statistical summaries of simulation results.

Figures III-4 through III-8 illustrate some of the performance summaries produced by INSSIM. For example, Figure III-4 provides statistics describing the number of units on hand and on order at the end of each simulated quarter, as well as counts of the number of units received from vendor shipments and serviceable returns. Figure III-5 presents similar counts of the number of expediting, rationing, disposal, and termination actions taken in the simulation, while Figure III-6 presents data describing average inventories and fill and backorder rates. Finally, Figure III-7

P E . . 0 F.

	(1)	(2)	(3)	(4)	(5)	**(9)	(2)	(8)	(6)	(10)**
PERIOD	INVENTORY ON HAND	INVENTORY ON ORDER	RECEIPTS	RETURNS	TOTAL SHIPMENTS	PRICEITY 1 TOTAL SHIPMENTS	DRIFES	TOTAL REDUJSJTJONS	REDS	PRIGRITY 1 REQUISITIONS
:									1 1 1 1 1 1 1	
BUP	103865	•								
1	93124	28931	0 ,	3121	13860	13860	28931	14959	6	14959
2	88419	33103	8455	3483	16646	16646	12427	16213	c	16213
*	0.0113	29129	17413	2533	14241	18251	13469	19266	c	.19266
4	85072	28422	13150	2472	20663	20463	12413	21627	C	21627
	41020	30703	12957	031	17031	17031	15238	15914	C	15914
9	81747	33183	13535	000	14616	11616	16015	14591	C	14591
1	R4067	21260	16181 .	613	13564	13584	426,8	13473	C	13473
	NACHA	22787	16672	299	14178	14178	18190	13328	C	13328
0	77434	32058	5842	1109	17857	17827	15073	17791	0	17791
10	74589	39341	7981	. 937	11763	11763	15264	13507		13507
11	81409	27490	10248	809	13327	13327	7397	12947	. 0	12947
12	H739A	15637	2116118	750	15440	15460	8835	14148	c	14148
;										
· TOTALS ·	1014470	342074	152082	18655	187206	187206	1,67719	187764	c	187764
AVE/YR	338157.	114025.	50694.	6218.	62462.	62402.	. 230042	62588.		62598.

- (1) Inventory on hand at the end of the quarter.
- (2) Total quantity on order at the end of the quarter.
- (3) Receipts of the replenishment orders.
- (4) Serviceable returns from customers of the supply system.
- (5) Total shipments to fill new customer requisitions or to fill backorders.

- (6) Total shipments to fill priority l requisitions or backorders.
- (7) Total replenishment orders initiated.
- (8) Total requisitions received.
- (9) Total outstanding backorders that are canceled by the customer.
- (10) Total priority 1 requisitions received.

Figure III-4. Receipts, returns, requisitions, and end-of-period measures.

^{**} Note: In the current study, all demands are priority 1.

REDRMANCE SIATISTICS

フィーエイエ

UNITS ...

(17)	TERMINATIONS	0	. 0	0	U	C	0	O	0	0	0	0	C		c	.0
(13)	DISPOSALS	c	C	0	0	0	0	0	0	0	0		0		0	0
(12)	MATTUNING	c	0	u	7	0	0		0	0	0	0	0		0	.0
(11)	Expenites	e	0	c	U	C	=	0	0	c	9	•	U		3	0.
	PERIOD	-	2	۲.	4	£	4	7	4	0	10	11	12	:	*101ALS*	AVEZYR

(11) Total expediting actions initiated.

(12) Total of all rationing actions within the period.

(13) Total disposals within the period.

(14) Total terminations; i.e., totals for all replenishment orders that are cancelled or reduced when the inventory position exceeds the termination level.

Figure III-5. Expediting, rationing, disposal, and termination measures.

13

BRESPORANCE

				111	STINE				
	(15)	(16)**	(12)	(18)**	(19)	(20)	(21)**	(22)	(2)
	10141	PRIORITY 1	BACKOPNER	PRIORITY 1	INVENTORY	TOTAL	PRINPITY 1	TOT FILLS	PPI 1 FI
PFRIOD	PACKORDERS	RACKURDERS	Weeks	weeks	Weeks	FILLS	FILLS	/INT RFO	/PP! 1
:-	1000	1000	3127	3127	1186380	13828	13828	1.92	.0
	444	649	13580	13580	1976624	15418	15418.	40.0	
	1681	1641	12507	12507	1964541	17749	17749	0.02	٠,
	26.45	26.45	17007	17007	1074017	18765	18765	1.87	· u
ď	1523	1528	22000	22900	198683	13000	13000	0.82	
	1503	1503	18692	18692	991353	13577	13577	0.03	0.
. 1	1392	1302	20116	21116	1045.332	12524	12524	10.03	
α.	545	542	. 12731	12731	1036357	12147	12147	0.01	
. 0	506	505	3740	3780	947006	16738	16738	0.04	
11	2254	2258	16021	16921	882825	11057	111657	0.82	.0
11	1670	1870	25436	25436	9526.96	0569	6990	0.74	0.
12	1,54	853	13463	13463	1015204	126.86	12486	.00.0	
:									
.TOTALS.	16240	16240	180350	180350	12321618	167058	167058		
AVEIVR	5113.	5413.	60117.	60117.	4107206.	. 55686.	55646.	n.80n	.0

REGS

- (15) Total backorders outstanding at the end of the period.
- (16) Total priority 1 backorders outstanding at the end of the period.
- 3 requisition-weeks of backorders, and 3 X 12 = 36 unit-weeks of backorders for (17) Total backorder-weeks observed during the period. For example, if one item has a backorder status for 3 weeks, there are single requisition for 12 units in a that item.
- (18) Total back-order weeks observed for priority lo

If there are 15 units on hand for the first for the remaining 4 weeks, a total of (15 \times 8 + 6 \times 4)== 144 inventory unit-weeks 8 weeks of a quarter, and 6 units on hand (19) Total number of inventory-weeks observed. were observed in the period.

168.

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0

- (20) Totals for all requisitions that were filled "off-the-shelf", i.e., that were filled without backordering.
- (21) Total fills for priority 1 requisitions.
 - (22) Fill rate for the period.
- (23) Priority 1 fill rate.

^{**} Note: In this study, all demands are priority 1.

		U	0	0					0			U
					0	ORDER COST STATISTICS"	TATISTICS.	***				
TINE	S	SMALL DRIFES	8		LARSE ORDERS	v	. 10	. TOTAL NABERS				
CUST TO ORDER	ORBER	260.47			460.27							
	NUVAFF	UNITS	DOLLARS	NUMBER	UNITS	DOLLARS	NUMBER	STINO	SHALLOR			
POP	0		c	6	0	0	=	G	0			
1	22	27366	97649	2	1565	30806	24	28931	128545			
2 .	15	11513	64854	. 1	1094	14222	16	12627	79886			
۴.	é. 1	13469	32130	6	0	0	10	13469	32130			
	0	0434	37661	2	2979	39727	12	12413	76388			
r	14	15111	5775A	-	127	13843	15	15238	711193			
4	15	16015	56355	0	c	0	15	16015	50355			
1		4253	13429	0	U	0	4	4258	13429			
· ·	13	16936	43146	2	1203	24504	15	18199	676511			
•	15	13402	55123	1	1581	20553	16	15073	75076			
10	13	151.39	50260	1	134	146116	14	15264	6.4666			
11	10	0009	42077	~	1307	25567	12	7307	67644			
. 12	0	7695	24807	2	1230	24774	111	8835	53581	\		
TOTALS	140	156419	572751	15.	11510	207692	164	167719	780443	•		
24411	TSOU GROSS COST	11.40210630F 85		SIARGE	PLUS LARGE DRIPER COST	0.69040500	0.69848580E 04 EGHALS TOTAL REBER COST	2 10101 6	TSUS COST	0.47114680F 05	. 50	
							,					
FOR RUY	BULLAS &	FOO BUY BULLAR REFAK POINT	T 10000.00	0		,					•	

III-I4

SMALL DROEP COST 0.112722280E 37 PLUS LARGE ORDER COST 0.13292240E 37 EQUALS TOTAL ORDER COST 0.26584560E 37 AVERAGE COST/ITEM/YR

4

Figure III-7. Order Cost Summaries.

summarizes ordering actions using large and small purchasing methods, and Figure III-8 plots on hand stocks, on order stocks and backorders as a function of time.

In INSSIM, all statistics are accumulated according to three different measures; they are:

- a. The number of distinct federal stock numbers or distinct actions associated with the current event.
- b. The quantity of units associated with the event.
- c. The dollar value of all units associated with the event.

For example, suppose a replenishment order for 12 units of a \$10 item is placed. In this case, INSSIM records that there was one order action, 12 units were ordered, and \$120 was the value of the order. The results presented in Figures III-4 through III-8 are all reported in terms of unit counts. However, INSSIM also produces similar tables summarizing the action and dollar counts recorded in the simulation.

This concludes our discussion of the Inventory System Simulator. In the next section, we will discuss how this model was used to evaluate the relative cost-effectiveness of the alternate PT-formulas.

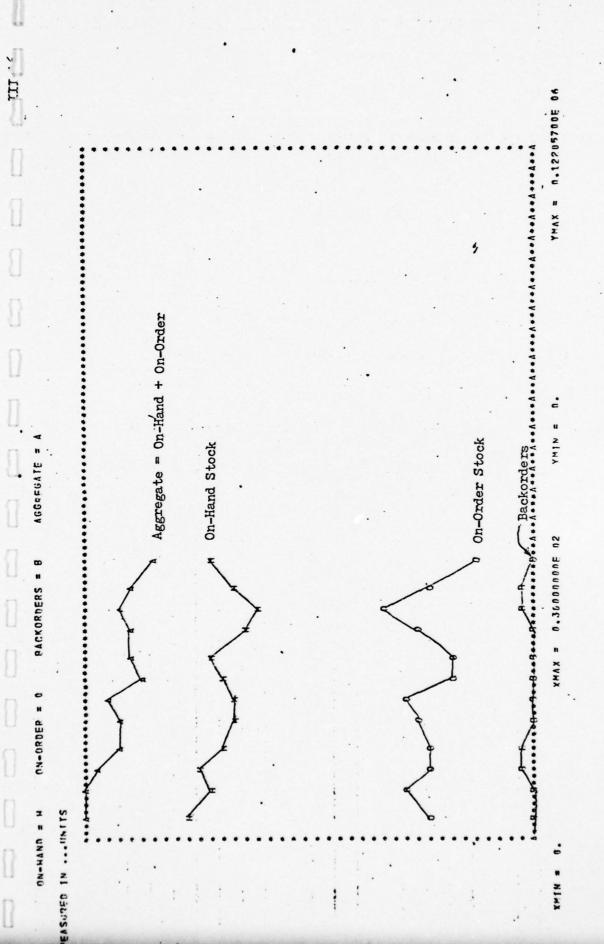


Figure III-8. On-hand and on-order assets and backorders verses time.

CHAPTER IV

MAJOR MODEL CONCEPTS

To understand the detailed program structure of INSSIM, the reader must possess a clear understanding of (a) the methods used to simulate the passage of time, (b) the events that simulate significant inventory system transactions, and (c) the data files that record current system status and that measure simulated performance. These major elements are the subject of this chapter.

The Timing Mechanism

The basic modeling concept employed in INSSIM is that of an "event." An event is a specific point in time in which the state or condition of the system changes or potentially changes. For example, the amount of stock on hand changes if a requisition is received and goods are shipped to fill the demand. Hence, receipt of a customer requisition is an event. Other events that may change the amount of on hand stock include delivery of a replenishment order by a vendor of the supply system and the return of serviceable assets from a customer.

The Future Events List

The sequencing of events through time is controlled by a Future Events List (FEL). The FEL is a list of all events

scheduled to occur at some future (simulated) time. For each event on the list, the following values are recorded.

JTIME - The time the event is scheduled to occur.

JTYPE - The event type (code).

JOTY - The quantity associated with the event (if applicable).

JPRIOR - For a requisition event (code = 1), JPRIOR
 denotes the requisition priority, where 1 =
 high priority, 2 = low priority. For other
 event types, JPRIOR has special meanings, as
 discussed below.

For example, suppose a high priority requisition (event type 1) for 35 units of item number 6 is received. In this case, JTYPE = 1, JFSN = 6, JQTY = 35, and JPRIOR = (high priority). The method for setting the time variable, JTIME, will be discussed below.

Structurally, the FEL is a linked list in ascending order by scheduled event time. In such a list, new entries to the list are inserted in a previously unused data storage location, and pointers are used to indicate the correct sequencing of the entry in the list. The major variables associated with this list are shown in Table IV-1.

At the beginning of each simulation run, subroutine INFEL is called to initialize the pointers and control variables associated with the FEL. Scheduled events are

TABLE IV-1. Future Events List Variables

NFEMAX = maximum number of entries on Future Events list

NENTRY = number of entries on the Future Events list

K = list index

JTIME(K) = clock time of transaction

JTYPE(K) = event type, as defined in Table IV-2

JPØINT(K) = pointer to next transaction in list

JFSN(K) = stock number identification*

JQTY(K) = quantity involved*

JPRIØR(K) = priority, * where

JPRIØR = 2 low priority

NFIRST = location of first transaction on chain

NTIME = time of earliest transaction on list

NLØC = location of last transaction placed on the chain

NOTE: If JTYPE(K) = 2, denoting a receipt event, JPRIØR(K) contains the pointer to the next most recent outstanding order for the same FSN, if any.

*if applicable

then entered and removed from the Future Events List by subroutines ENTER and REMOVE, respectively. New events are inserted into the FEL by the following CALL statement:

CALL ENTER (ITIME, ITYPE, IP3, IP4, IP5) where

ITIME = scheduled time for the event to occur.

ITYPE = event type (code)

When subroutine ENTER is called, the new data is recorded, and the list pointers are updated to insert the new event in the proper time sequence.

Events are removed from the Future Events List by subroutine REMOVE; the CALL statement takes the form

CALL REMOVE (ITIME, ITYPE, IP3, IP4, IP5)

and the calling parameters are as defined above. Subroutine REMOVE removes the <u>first</u> entry from the FEL and updates the pointers accordingly; that is, it deletes the list entry with the smallest (earliest) scheduled clock time from the FEL, and returns the corresponding data values through the parameter list.

Subroutine WRIFEL is another routine associated with the Future Events List. In debugging new INSSIM models, it is sometimes desirable to write out the entire Future Events

List at selected times within a simulation run. Subroutine WRIFEL fulfills this function.

Timing Conventions

To simplify programming and analysis tasks, it was desirable to establish timing conventions that differ slightly from values associated with the Gregorian calendar.

Specifically, INSSIM assumes that each day consists of 100 Time Units (TU). Days, weeks, months, and years are then assumed to be related as shown in Table IV-2. Since the values are used repeatedly throughout a simulation run, specific COMMON variables are established for each of these time units. These variables are also shown in Table IV-2. Values of these variables are initialized by subroutine INITAL at the beginning of each INSSIM simulation run.

INSSIM Events

In the Inventory System Simulator, three categories of events are used to simulate the FOQ Buy Computation System. They are:

a. Material flow events - describing the receipt of a customer requisition, delivery of a replenishment order, or the return of serviceable assets.

TABLE IV-2. Time Conventions*

Time Interval	Basic Value	Time in TU's		INSSIM Variable
1 Day		100 TU's	=	ITDAY
1 Week	7 Days	700 TU's	=	ITWEEK
1 Month	4 Weeks	2,800 TU's	=	ITMNTH
1 Quarter	3 Months	8,400 TU's	=	ITQTR
1 Year	4 Quarters	33,600 TU's	=	ITYEAR

^{*} It is assumed that 1 Day = 100 Time Units (TU's), and each INSSIM Time Variable is expressed in TU's.

- b. Management action events describing important management decision points. The calculation of control levels, status reviews to determine what reorder, termination, or disposal actions are appropriate, and the establishment of budgets and procurement guidelines are examples of these events.
- c. Simulation bookkeeping events events to collect time-valued statistics, to generate demand and serviceable returns, and to signal the end of the simulation.

At present, thirteen possible events are included in the INSSIM model. These events are listed in Table IV-3. In INSSIM, there is a separate FORTRAN subroutine to describe how each event changes the state of the system, and to record associated performance statistics. Table IV-3 also presents the subroutines associated with each event and the definitions of the IP3, IP4, and IP5 parameters used in calling subroutines ENTER and REMOVE.

All INSSIM events may be classified as either (a) scheduled events, (b) random events, or (c) dependent events. Scheduled events are events with a specific schedule of occurrence times. For example, inventory status reviews (event type 5) occur at the end of every week, and the History File Update event (event type 9) occurs at the end of every quarter. On the other hand, customer requisitions (event type 1) and serviceable returns (event type 4) are random events—the time of occurrence of these events is not known in advance. Finally, the delivery of a replenishment order (event type 2) is a dependent event since the time of delivery is dependent

TABLE IV-3. INSSIM Events

Event Type	Event	Event Subroutine		Paramet	ers ,
			IP3	IP4	IP5
1	Requisition	REQ	N	QTY	Priority
2	Receipt of Replenishment Order	RECEIV	N		pointer
3	Cancellation	CANCEL	N		
4	Serviceable Return	RET	N		
5	Inv Status Review	STATUS			
6	Levels Computation	LEVEL			
7	Buy Guidelines	GUIDE			
8	Budget Review	BUDGET			
9	Update History File	FORUPD			
10	End of Run	OUTPUT			
11	Special Statistics	SSTAT	KEND		
12	Generate Requisitions and Returns	DEMPAR			
13	Trace ·	MAIN			

where

N = item number

QTY = quantity associated with this event KEND = week number within the current quarter

upon earlier management reordering decisions. Dependent events are caused by the occurrence of an associated random or scheduled event.

In INSSIM, the first occurrence of each scheduled event is created by subroutine INITAL; that is, INITAL puts an entry on the Future Events List for each scheduled event at the beginning of a simulation run. Subsequent scheduled events are put on the Future Events List each time a new scheduled event occurs. For example, at the conclusion of a status review event (event type 5), a subsequent type 5 event is scheduled to occur one week in the future.

Specific values for the time between scheduled events are set in subroutine INITAL. Table IV-4 defines specific time variables initialized in this routine.

At present, receipt of a customer requisition and of serviceable returns (event types 1 and 4) are the only random events simulated in INSSIM. These events are scheduled by subroutine DEMPAR. The process for accomplishing this is discussed in detail in Chapter VI.

TABLE IV-4. TIMING VARIABLES Established in INITAL

Variable	Definition
IQTRND	clock time that marks end of current quarter ,
ITINV	number of current quarter
ITIME	current simulation clock time (100 Time Units = 1 day). At the beginning of a simulation run, ITIME = 0.
ITLEVL	clock time of the next computation of stock levels
IDLEVL	time interval between stock level computation
ITDIV	clock time of the next division level review
IDDIV	time interval between division level reviews
ITFOR	time of the next update of demand history records (Event type 9)
IDFOR	time between history file updates
ITHQ	time of next Headquarters USAF stock fund budget review
IDTHQ	time between Headquarters USAF budget reviews
ISTOP	clock time that simulation is to be stopped
ISTAT	clock time for activating statistics collection routines
IDSTAT	time interval between statistics collection
INQTR	number of quarters to be simulated

An Illustration

Figure IV-1 illustrates the interaction of the ENTER and REMOVE routines in the management of data in the Future Events List. As noted above, at the beginning of an INSSIM run, scheduled events are entered onto the FEL by subroutine INITAL. Figure IV-1(a) illustrates data stored on the FEL at this time. At the beginning of the simulation run, the simulated clock time (ITIME) is set to zero, and seven events are placed on the Future Events List. Note that a type 5 (JTYPE = 5) event is scheduled to occur at time 40 (JTIME = 40). Next, a type 6 event is inserted on the FEL to occur at time 30. Event types 11, 10, 9, 12, and 13 are also placed on the FEL by subroutine INITAL.

The variable NFIRST identifies the storage location of the most imminent event on the Future Events List; that is, the event with the lowest scheduled event time. The variable NENTRY identifies the total number of events on the Future Events List at the current time, while the variable NTIME specifies the clock time associated with this most imminent event.

As noted above, subroutine WRIFEL may be called to print
the entire contents of the Future Events List. Figure IV-1(b)
illustrates the output of WRIFEL at the beginning of the
simulation run associated with the data presented in Figure
IV-1(a). Note that at this time, there are seven entries on
the Future Events List (NENTRY = 7), and the most imminent of
these events is the seventh entry in the FEL (NFIRST = 7).

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Figure IV-1. Event Routine Interactions

a) Entering of initial INSSIM events on the FEL by Subroutine INITAL

ITIME

Coutine

EN NEER ERRER

11 10 20 30 3400 8400

b) WRIFEL Output at Beginning of Simulation

III	TIME	317/1		• =	8400 10 0			
					• •		•	•
NEW YEAR	,	TPRIOR	-			. 0		•
H		5001	0		• 4	. =	. 17	8

c) Initial Simulation Events

NTIME	30		‡
NENTRY	,		
NFIRST	2		-
Y			~
JARIOR	•		•
TOTY	0		•
JFSN			•
STYPE	13		•
STIME	200		1430
**	,	2	-
Keriok	•	0	•
KOLY	•	0	•
KESM	0	•	•
KTYPE	13	9	
ITIME		3.0	30
ROUTINE	ENTER	REMOVE	LNIFR

*K = row number in the FEL in which the current line of data is stored

Figure IV-1(c) illustrates the initial events that occur at the beginning of the INSSIM simulation run associated with the data given in IV-1(a). Note that at time = 0 (ITIME = 0) a type 13 event (KTYPE = 13) is removed from the Future Events List. As shown in Table IV-3, a type 13 event causes on-hand and on-order stock status information to be recorded for later plotting by the MAIN routine. This event also causes another type 13 event to be scheduled to occur one week (i.e., 700 time units) in the future. This scheduling is indicated by the second line of Figure IV-1(c). The next event on the Future Events List is a type 6 event. This event is removed at time 30 (ITIME = 30). As shown in Table IV-3, a type 6 event causes subroutine LEVEL to be called to compute levels for all items being simulated. When this is completed, another levels computation is scheduled to occur at time 1430 by placing a type 6 event on the Future Events List. Finally, Figure IV-1(c) indicates that a type 5 event is removed from the Future Events List at clock time 40. A type 5 event causes subroutine STATUS to be called to initiate a status review of the on-hand and on-order stocks of each inventory item. After the status review is completed, another status review event would be placed on the Future Events List.

The process illustrated above is then continued repeatedly throughout the simulation. Required simulation events are placed on the Future Events List by subroutine ENTER, and are subsequently removed from this list at the appropriate scheduled time by subroutine REMOVE.

DATA FILES

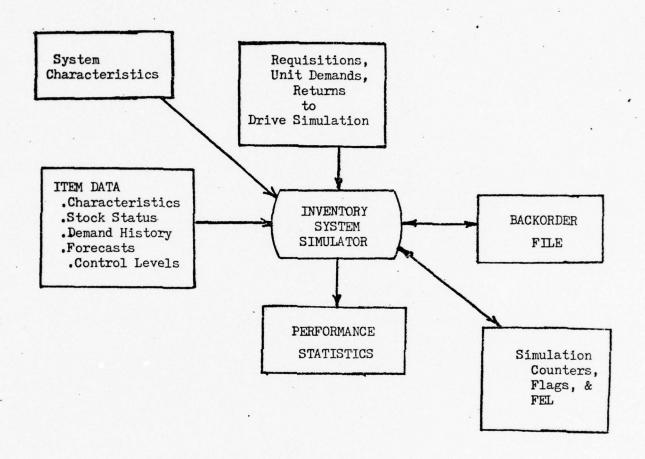
A large number of data elements are required to operate any computer simulation model, and INSSIM is no exception. The major categories of data associated with INSSIM are illustrated in figure IV-2. As shown in the figure, INSSIM data elements may be logically classified into one of the following files:

- 1. System Characteristics File
- 2. Item Data File
- 3. Backorder File
- 4. Demand Driver File
- 5. Performance Statistics File
- 6. Simulation Counters and Flags File

Let us now consider the contents of each of these files.

SYSTEM CHARACTERISTICS FILE

The Systems Characteric File contains data elements that define the system as a whole. The number of items managed by this system in a single simulation run, the cost of processing orders using small purchase and advertised procurement methods, and levels computation codes are examples of data elements in this file. This information is provided primarily



Firgure IV-2. Logical Data Files in INSSIM.

through inputs of file 05. Specific data elements input through this file will be discussed in detail in chapter VII.

ITEM DATA FILE

The item data file contains information specifically related to each item being simulated. An item's unit cost, its current level of on-hand and on-order stocks, and control levels (e.g., ROL, termination level, or retention level) are examples of this type of data element. Table IV-5 presents a detailed list of information items which are contained in this file. As shown in table IV-5, the item data file contains several subcategories of information. These define (a) specific physical and management characteristics of the item, (b) data describing the stock status of the item, (c) variables describing the demand history for the item, (d) forecast variables which quantify forecast usage rates and demand variability and (e) control levels used in the management of the item's inventories.

Table IV-5. Item Data File Variables

ITEM CHARACTERISTICS

	Variable	Definition
	N	Item Index
	NITEM	Number of items simulated
	ALC	Air Logistics Center that manages
		this item
	FSN	Federal Stock Number, where
		FSN(1) = Material Management Code
		FSN(2) = Federal Stock Class
		FSN(3) = First six characters of NIIN
		FSN(4) = Remaining characters of NIIN
	UM	Unit of measure
	NOUN	Item name
	MGTCD	Item Management Codes, where
		the specimental means to be the state of the
		MGTCD(1) = Essentiality code
		MGTCD(2) = Supply management grouping
	SHEER CAR CONTRACTOR	MGTCG(3) = Weapon system code
		MGTCD(4) = Type computation code
	UCOST(N)	Unit cost (dollars)
	LTADM(N)	Administrative lead time (months)
ITEM	STOCK STATUS	
	INVACT(N)	Actual inventory on hand (units)
	INVDUE (N)	Inventory due-in from supplier (units)
	NBOIU(N)	Priority I backorders, in units
	NBOIR(N)	Priority I requisitions backordered
	NBOTR(N)	Total requisistions backordered, all
		priorities
	NBOTU(N)	Total backorders, all priorities,
		in units
	NORDPT(N) *	Pointer to most recent outstanding
		order
	NBOPT(N) *	Pointer to oldest, highest priority

*Note: By convention, pointers are set to zero if there are no other elements in the data chain.

backorder

Table IV-5. Item Data File Variables

HISTORY VARIA	BLES
---------------	------

(Continued)

NDHIS

NDENT (N)

NDEMAC (N)

NDEMND (N, I)

NREQ(N)

Number of periods saved in

history file

Number of forecast periods since item entered system (negative values indicated item has not yet entered

system)

Counter to accumulate demand for Nth

item during the current forecast

update period.

Demand for item N during Ith past

period, I=1, 2,..., NDHIS

Counter to accumulate the number of requisitions for item N during

the current period.

FORECAST VARIABLES

ADR(N)

RMEAN (N)

RTREND (N)

RMAD (N)

PERSUM(N)

KNT(N)

RSIGLT (N)

REQSIZ(N)

REQMAD(N)

Net annual demand rate for item N the net rate of unit demands less servicable returns.
Estimate of demand during next demand period.

Estimate of trend in demand per

period.

Standard deviation of lead time

demand

Sum of past forecast errors

Counter used for adaptive smoothing

forecasts

Estimate of standard deviation of

lead time demand

Estimate of mean requisition size

for item N.

mean absolute deviation of requisition

size for item N.

CONTROL LEVELS

IROL(N)

IRQTY(N)

ISUL(N)

IRL(N)

ITL(N)

Reorder level
Reorder quantity
Support level
Retention level
Termination level

BACKORDER FILE

The backorder file records all outstanding backorders in the inventory system at a given point in time. This file contains a record for each requisition in a backorder status. Specific data elements in this file are defined in Table IV-6. Included in these data elements are the item number associated with the backorder, the backorder quantity and priority, and the time the item was backordered. A pointer system is used to relate entries in the backorder file with the specific items associated with that backorder. These pointer variables are also defined in table IV-6.

DEMAND DRIVER FILE

The demand driver file contains data elements required to generate the demands and serviceable returns that drive the inventory system. The number of requisitions and the associated units per quarter and the number of serviceable returns to be generated each quarter are examples of data elements in this file. Table IV-7 defines specific variables associated with the demand driver file.

TABLE IV-6. BACKORDER FILE

Variable Name	Definition
J .	File Index
ITMBAC(J)	simulated clock time that the Jth entry in the backorder file was placed into the file
IDFSNB(J)	<pre>item number associated with the Jth back- order</pre>
IPRIØR(J)	priority of Jth backorder
IQTYB(J)	quantity backordered
IBACPT(J)	<pre>pointer to the file entry of the next backorder for this same item</pre>
NBMAX	maximum number of entries in backorder file
ILØCBK(K)	<pre>index of Kth unused data location in back- order file</pre>
NLØCBK	number of unused data locations
TABLE	IV-7. DEMAND DRIVER FILE
IDEMND(N,J)	Number of units of demand for item N during period J
IRETUR(N,J)	Number of serviceable Returns for item N during period J
IREQ(N,J)	Number of requisitions for item N in period J associated with the unit demands IDEMND(N,J)

Subroutine DEMPAR is called at the beginning of each simulated quarter. This routine uses information in the Demand Driver File to generate specific requisition and serviceable return events. DEMPAR accomplishes this in such a way that the total requistions placed within a quarter exactly equal the number of units of demand which are input through the Demand Driver File. Chapter VI discusses the demand generation process in detail.

PERFORMANCE STATISTICS FILE

The Performance Statistics File contains measures of the levels of activity observed during a simulation run. Table IV-8 defines specific data elements contained in this file.

As illustrated in Table IV-8, performance measures are recorded in three different units of activity. That is, each type of activity is recorded in terms of (a) the number of actions or federal stock numbers associated with that activity, (b) the number of units of a specific item associated with that activity and (c) the dollar value of the number of units associated with that activity or action. For example, if an order is placed for a \$10 item and 21 units are purchased the variable IORDER (I,1) would be increased by 1, since it counts

TABLE IV-8. PERFORMANCE STATISTICS FILE

Variable	Definition
I	period index
J	<pre>type of measure, where J = 1 actions/FSN 2 units 3 dollars</pre>
INVØH(I,J)	inventory on hand at end of period
INVØR(I,J)	inventory on-order at end of period
IRECET(I,J)	receipts
IRETRN(I,J)	returns
INVDAY(I,J)	inventory-weeks
IØRDER(I,J)	orders placed
IDISPS(I,J)	disposals
ITERM(I,J)	terminations completed
IEXPED(I,J)	expediting actions
IRATON(I,J)	rationing actions
IREQC(I,J)	total requisitions cancelled
IREQT(I,J)	total requisitions
IREQI(I,J)	priority I requisitions
IBACKT(I,J)	total backorders (end of period)
IBACKI(I,J)	priority I backorders (end of period)
IBAKDT(I,J)	total backorder weeks
IBAKDI(I,J)	priority I backorder weeks
IFILLT(I,J)	total fills (Number of requisitions filled immediately upon receipt)
IFILLI(I,J)	priority I fills
ISHIPT(I,J)	total shipments
ISHIPI(I,J)	total priority I shipments

TABLE IV-8. (CONT'D)

ISMORD(I,J)	total small orders
ILGORD(I,J)	total large orders
IBOPOH(J)	On hand inventory at beginning of simulation
IBOPOR(J)	on-order inventory at beginning of simulation

the number of orders placed. The variable IORDER (I,2) would be increased by 21 units, since this variable records the number of units ordered during period I. Finally, the variable IORDER (I,3) would be increased by 210, since an order for 21 units which cost \$10 each represents a total dollar activity of \$210. All of the other performance measures defined in table IV-8 are updated in a similar manner.

SIMULATION COUNTERS AND FLAGS

Every simulation model requires a series of counters and flags that are required to control the progress of the simulation, and to perform necessary bookkeeping tasks. The number of quarters to be simulated, the number of the current statistics collection interval, and the number of simulation runs to be performed are examples of these types of data elements. The variables of the future events list (FEL) defined in Table IV-1 are an important example of this type of data. Other major variables in this category are defined as inputs to INSSIM through File 05. These later variables will be discussed in detail in chapter VII.

We have now reviewed the major concepts which are the building blocks of the INSSIM simulation model. We've discussed timing mechanisms involved in the model and the events used to represent inventory system activities. The data files used to describe the status of the current system, to drive the simulation model, and to update performance statistics were also discussed. In the next chapter, we will discuss the workings of the MAIN routine. This routine is the primary INSSIM routine, in that it weaves all of the major concepts discussed here into a working model of a single location inventory control system.

CHAPTER V

MAIN PROGRAM

The MAIN program is the work horse of the Inventory

System Simulator. This routine is responsible for the

control of input data, initialization of status and

performance variables, the scheduling of simulation events,

and the control of output products. An understanding of this

routine is essential for those who desire to enhance the

current system.

A general outline of the MAIN program is presented in Figure V-1. As shown in the figure, the initial portion of MAIN is concerned with initializing the statistical accumulators and status variables maintained by the system, and in initializing the Future Events List.

After initialization, MAIN controls the scheduling of simulated events, and the calling of associated event subroutines. To do this, subroutine REMOVE is used to remove the most imminent event from the Future Events List. This event is called the "current" event. The program then branches based on the event code of the current event. As shown in Figure V-1, separate subroutines are used to perform bookkeeping functions associated with each event type. For example, event type 1 represents a customer requisition. When a type 1 event is removed from the Future Events List, subroutine REQ is called

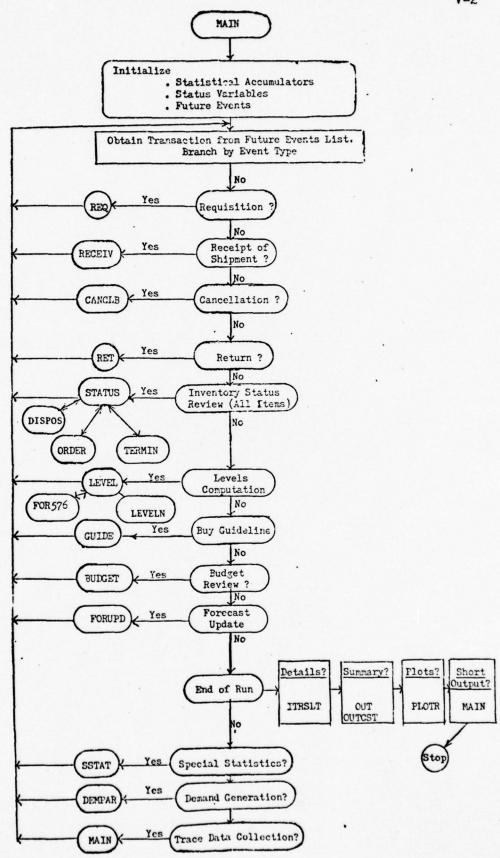


Figure V-1. General Outline of MAIN Program

to perform the associated bookkeeping tasks. Similarly, for event types 2 and 3, subroutines RECEIVE and CANCLB, respectively, are called.

The event subroutines may in turn call other routines to assist in the update calculations. For example, subroutine STATUS is called to simulate the occurrence of an inventory status review (event type 5). This routine in turn calls subroutine STATN to determine appropriate management actions associated with a given item N. If appropriate, STATN may in turn call the routines ORDER, TERMIN, or DISPOS to represent procurement, contract termination, or disposal actions, respectively.

Event type 10 denotes the end of the simulation run.

When this type of event is removed from the Future

Events List, one or more output routines may be called.

Specific output products produced are specified by parameters which are input through File 05. A detailed discussion of these control parameters is presented in Chapter VII.

If detailed simulation results by item are to be produced, subroutine ITRSLT is called. If tabular summaries are desired, subroutines OUT and OUTCST are called. If plots of important inventory characteristics are desired, subroutine PLOTR is called. Finally, an optional abbreviated performance report may be requested that is useful in the debugging of INSSIM enhancements.

A detailed flow chart of the MAIN program is presented in Figure V-2. As shown in the figure, MAIN first sets several management parameters that are used if alternate levels calculations are not specified. Definitions for the variables GTLF, GRLF, GSULF, and GSLF shown in Figure V-2 are presented in Table V-1. These values are used in levels calculations performed by subroutine LEVELN. After initializing the above variables, MAIN reads simulation run parameters specified in File 05. These inputs are discussed in detail in Chapter VII. The "run" loop then begins. An input parameter, NRUN, specifies the number of distinct simulation runs to be performed. The variable CSHORT(K), which is provided as input in File 05, specifies the value of the Lagrange multiplier to be used in the Kth simulation run. Hence, the value of the variable CSHORT is set to the appropriate value for use in the current simulation run.

Next, MAIN initializes the random number stream, rewinds the item data file (File 07), and zeros the statistical accumulators arrays.

Subroutine INITAL is now called to initialize the time parameters associated with the simulation run, and to create the initial scheduled events by putting them on the Future Events List. Subroutine INITEM is then called to read in input data for the NITEM items that are

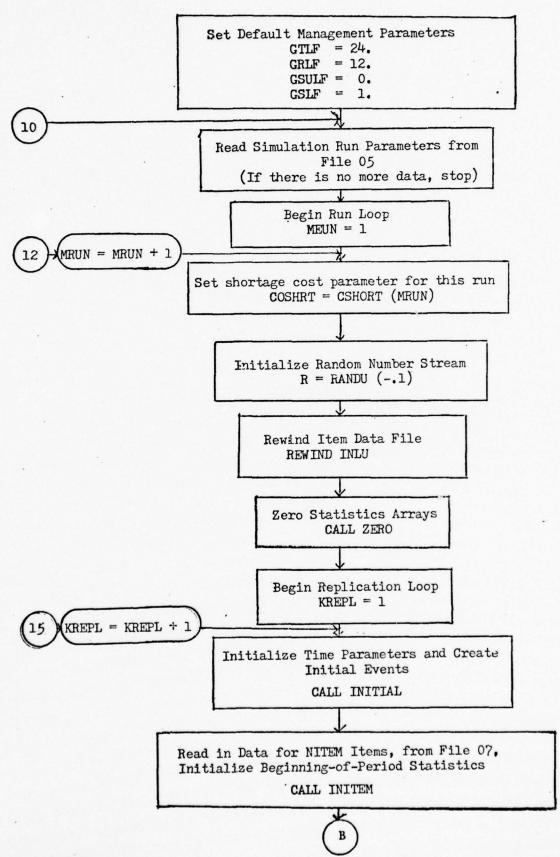


Figure V-2. The MAIN Frogram.

9 -

TABLE V-1

DEFAULT VALUES FOR LEVELS CALCULATIONS

<u>Variable</u>	Definition
GSLF	safety level factor (in months)
GROOF	order quantity factor (in months)
GTLF	termination level factor (in months)
GRLF	retention level factor (in months)
GSULF	support level factor (in months)
GEØQF(I)	order quantity factor for Ith demand rate class

Formulas

MR = monthly demand rate in units

lead time requirement RLT = (admin + prod lead time) *MR

safety level SL = GSLF*MR

reorder quantity ROQ = GROQF*GEOQF(I)*MR

reorder level ROL = RLT+SL+

termination level TL = ROL+GTLF*MR

retention level RL = TL+GRLF*MR

support level SUL = GSULF*RLT

to be included in the current simulation replication.

This data is read in from File 07.

Simulation of specific inventory events now begins.

Subroutine REMOVE is called to remove the most imminent event from the Future Events List, and MAIN then branches based on the event code of this event. Figure V-2 specifies the specific subroutines that are called during this stage of processing. Detailed narratives describing each of these programs are contained in Volume II of this report.

Observe that when a type 10 event occurs, the variable KREPL is checked to see if the replication count exceeds NREPL, the number of replications specified for the current simulation run. If not, KREPL is increased by one, the program returns to block 15 to read in a new set of item data and to perform another replication of the simulation. If, on the other hand, KREPL equals NREPL, simulation run statistics are produced. If the output control parameters IOUT equals one, subroutines OUT and OUTCST are called to present tabular summaries of the aggregate performance statistics observed during the NREPL replications of the simulation experiment. If IGRAPH equals one, subroutine PLOTR is called to produce graphical results. If IPUNCH equals one, the abbreviated statistical summary is written from MAIN.

After output products are produced, MAIN tests to find if all requested runs have been performed. If so, the simulation stops. Otherwise, MAIN returns to statement number 12. The run counter, MRUN, is then incremented, the shortage cost parameter COSHRT is reset to the new Lagrange multiplier value, and the initialization process begins again. The sequence of initialization, simulation, and output operations is repeated until all requested simulation runs are performed.

CHAPTER VI

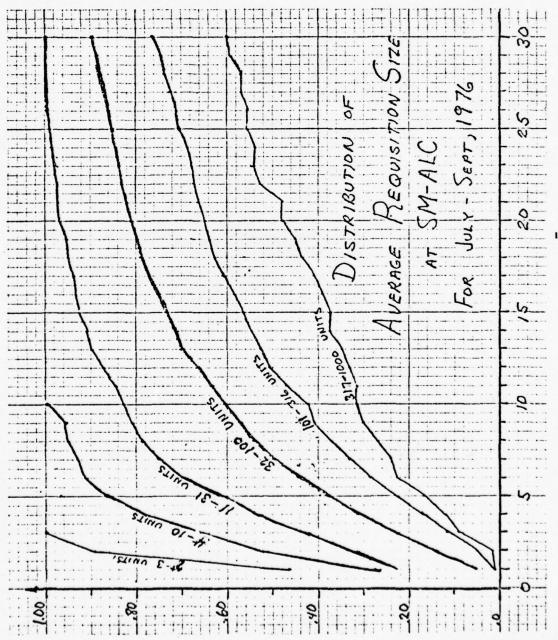
THE DEMAND GENERATION PROCESS

An important feature in the development of any simulation model is the method for representing customer demands. In our model, actual usage history for EOQ items was used as the basis for the demand generation process. These histories contain the number of units that were demanded by quarter since fiscal year 1971. Unfortunately, detailed historical information on the nature of specific requisitions placed for each item was not recorded. Consequently, it was necessary to develop a method for describing the requisition generation process using the recorded quarterly usage history as a starting point.

In developing the demand generation process, we relied heavily on the statistical results discussed in Section II of reference 2. The distribution of average requisition size was a primary result of that section. This distribution is reproduced in Figure VI-1.

A flow chart of the steps used to generate requisition sizes with the same statistical characteristics as shown in Figure VI-1 is presented in Figure VI-2.

As shown in the figure, the demand generation process begins by considering the number of units, D, that were demanded in a given historical quarter. We next determined the demand class associated with this particular level of



P (AVERAGE REQUISITION SIZE & R)

"Igure VI-1, Distribution of Average Requisition Size.

AVERAGE REQUISITION SIZE (R

Once the appropriate demand class is identified, demand. a Monte Carlo process is employed to simulate the specific number and size of requisitions associated with a total demand of D units. Block C of Figure VI-2 illustrates the major steps in the Monte Carlo process. The procedure begins by determining a random number X which is uniformly distributed on the interval between 0 and 1. conceptually equivalent to selecting a random percentile from the cumulative probability distribution of average requisition size. Next, the cumulative probability distribution illustrated in Figure VI-1 was used to determine the specific requisition size R associated with the random percentile X. This was our tentative value for the first requisition to be generated. We then check if the total cumulative units generated so far exceeds D units. If the cumulative units is less than D, the requisition generation process continues as described above. On the other hand, if the cumulative units exceeds D, the last requisition is This is to ensure that the total number of units requisitioned throughout the period exactly equals the amount D recorded in the item history record.

The above process determines a set of requisitions whose total units equal the total demand recorded in the item history record. To determine the time of arrival of each requisition, it is assumed that arrival times were uniformly

distributed throughout the quarter. A Monte Carlo process is then used to determine the specific arrival time for each requisition generated. This is equivalent to assuming that the time between arrivals is exponentially distributed within a quarter.

at the beginning of each simulated quarter. Subroutine

GETREQ is then called by DEMPAR to determine specific requisition sizes using the logic defined in Figure VI-2. DEMPAR

then places a type 1 (requisition) event on the Future Events

List (FEL) for each generated requisition. Finally, DEMPAR

places a type 13 event on the FEL to occur one quarter in

the future. This type 13 event triggers the next call to

DEMPAR.

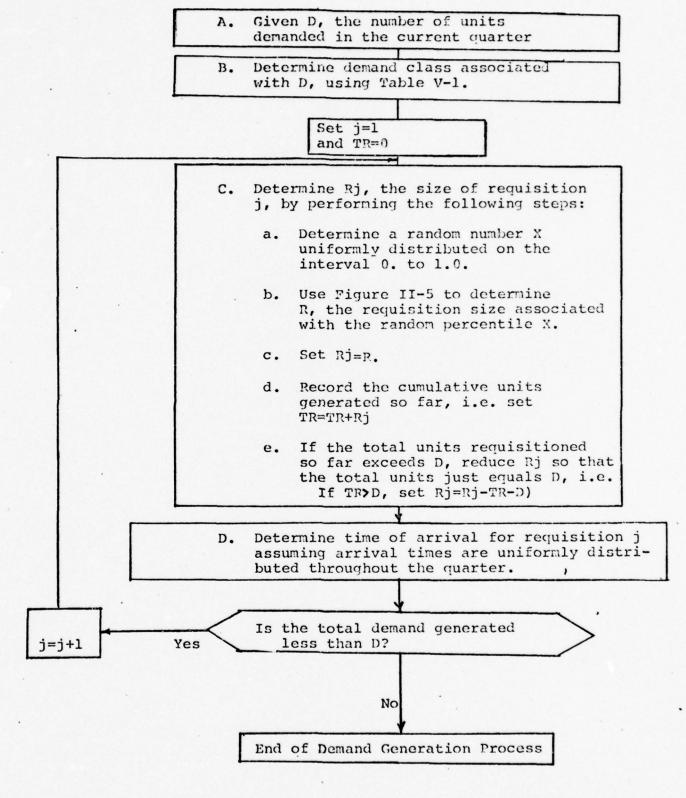


Figure VI-2. The Demand Generation Process

CHAPTER VII. INPUT SPECIFICATIONS

As illustrated in Figure III-2, INSSIM requires two input files, File 05 and File 07. File 07 specifies the characteristics of each inventory item to be simulated, while File 05 specifies the number, size, and characteristics of the simulation runs to be performed. Let us now consider each of these files in detail.

FILE 05: SIMULATION RUN SPECIFICATIONS

Eight different parameter cards are required to specify a given INSSIM simulation scenario. These cards provide the following types of data:

Card	Contents
1	Identification
2	Output Controls
3	Debug Flags
4	Input File Specifications
5	Management Methods to be Simulated
6	Management Parameters Required by the computational methods specified on card 5
7	System Cost Parameters
8	Simulation Size Specifications

Figure VII-1 presents a print back of a specific set of
File 05 input data. And this figure, labels on the left hand
margin identifies the FORTRAN variables associated with each
input parameter, while the specific numerical value assumed
by this variable is presented on the right. Brief definitions
of each of these input variables are presented in Table VII-1.

^{*}Inputs to File 05 are specified in free-field BCD format. See page C-1, Appendix C for an example.

	eulISNEAL.			Δ	
	PILIN PAPAMETERS	(CS) HANAGE	MANAGEMENT METHODS TO BE USED		
C1) KUN-10.	D. 3 TITLE. 100 ITEM SIMULATION WITH ZFRO SS	ICHFOR	FORECAST FORMULA = 1		
	•	100816	STD DEV FORMULA = 1		
C2) OUTPUT	OUITPUT CONTROLS(NOTE. 1=YFS)	160500	Eno FORMULA = 2		
TERT	17.4P 175= 0	1chSt.	SAFETY STY CUBE = 3		
TUO	SIPHADY = 1	ICUSIC	SAFETY LIMIT CODE = 1		
GRAPH	Geaphs = 1	1CPBG	AUDAFT GUTNE CUNE = 1		
PUNCH	PIINCH = 1	ICDSR	RETURNS COLF = 1		
C3) DEHIG FLAGS	LLLARS	(C6) MANAGI	MANAGEMENT DAPAMETEPS		
	104.16 = 0	NIMOUL	MIN END(MNTHS)	0.000.0	
	15840 = 1	FOOMAX	MAX EDREMNTHS)	36.0000	
	15416 = 0	SLMIN	MIN SAFETY LV(MNTHS)	.0	
	108:16 = A	SLMAX	MAX SAFFTY LV(MNTHS)	• 0	
	0 = 91:BH1				
		(C7) SYSTEM	PARAMETERS		•
TALCE	START TOACE AT O FOR ITEM 1	COSHID	POLOTING COST/5-INV	0.2100	
C4) 1TEH I	ITEM INPUT FILFS	CSHOPT	SHOOTAGE COST	10.0000 31.4000 100.	100.000
MLU	FILE = 7 TYPE = 2 (1 = BCD: 2 = BINARY)	CUSARP(1)	SMALL DONFR COST	269.8700	
Den .	24	COSORD(2)	LAPSE ORNER COST	460.2700	
		CSTARK	COST REEAK-POINT	10,000,0000	
		(68) SIPUL	SIPULATION SIZE		
		202	SAUG 30 GREWIN	-	
			מושים בר השיבורים	21	
		10.12	NO. OF BEPLICATIONS	100	
		MITEM	NO. OF TTEMS/REPL	1.	

Figure VII-1, Specifications for a 100 Item 12 Quarter Simulation Run.

Table VII-1. Simulation Run Parameters (File 05)

Card Type 1. Run Identification

Variable

IDENT	Run identification	number
TEXT	Description of the	current

Description of the current run (up to 40 characters). The description must be included in quote marks.

in quote marks

Definition

Card Type 2. Output Controls

ITWRT	If ITWRT = 1, call IRSLT to write
	detailed simulation results for each
	item to File 08.

ITOUT = 1, call OUT and OUTCST to print summary statistics for

each simulation run.

IGRAPH If IGRAPH = 1, call PLOTR to plot on hand, on order, requisition and backorder data verses time.

IPUNCH : If IPUNCH = 1, write a brief summary from MAIN after each simulation run.

Card Type 3. Debug Flags

IDEBUG	<pre>If IDEBUG = 1, write all entries</pre>
	and removals from the Future Events
	List.
IEBUG	<pre>If IEBUG = 1, print all item input</pre>
	data on File 06.
IFBUG	If IFBUG = 1, print item forecast
	data from FOR576.
IGBUG	If IGBUG = 1, write demand data
	generated by DEMPAR
THBUG	If IHBUG = 1. write item levels

calculations from LEVELN.

Card Type 4. Item Input File Definition

INLU	Logical unit number of item demand
	data input file.
INTYPE	· Format of item input file, where
	<pre>1 = Free-Field BCD format,</pre>
	2 = Binary Format

Card Type 5. Inventory Management Codes

Variable	Definition
ICDFOR	Forecast Formula Code used in FOR576 to estimate annual demand rate ADR(N).
ICDSIG	Formula code for estimating the standard deviation of lead time demand RSIGLT(N) in FOR576.
ICDEOQ	EOQ formula code used in LEVELN.
ICDSL	Safety level formula code used in LEVELN.
ICDSLL	Safety level limit code, used to compute limits on the safety level in LEVELN
ICDBG	Budget Guideline code Formula code for forecasting serviceable returns in FOR576.

Card Type 6. Management Parameters

EOQMIN	Minimum EOQ, in months supply.
EOQMAX	Maximum EOQ, in months of supply.
SLMIN	Minimum safety level, in months of supply.
SLMAX	Maximum safety level, in months of supply.

Card Type 7. System Parmeters

COSHLD	Cost of holding one unit in inventory
	for one year, expressed as a fraction
	of the item's price.
CSHORT (4)	Implied shortage cost. Four values
	are provided as input, for use in up
	to 4 sequential simulation runs.
COSORD(1)	Cost of processing a "small" order,
	an order whose dollar value is less
	than CSTBRK.
COSORD(2)	Cost of processing a "large" order.
CSTBRK	Cost break-point used to differentiate
	between large and small orders.

Card Type 8. Simulation Run Parameters

NRUN	The number of simulation runs to
INQTR	be performed. The number of quarters to be simulated in each run.

Variable

NREPL

NITEM

NDHIS

Definition

The number of replications to be perfomed within each simulation runs. The number of items to be simulated within each replication.

The number of quarters of information on the item data file to be used to initialize the simulation History File.

Let us now consider each of these input cards in more detail. CARD 1: RUN IDENTIFICATION

This card identifies the current simulation run. RUN ID is a numerical identifier which is recorded the detailed simulation results file 08. This identifier makes it possible to identify specific simulation runs using automated post-processing routines. The title simply identifies in words the type of simulation exercise being performed.

CARDS 2 and 3: OUTPUT CONTROLS

These two input cards specify the types of output products which are to be produced during the simulation run. Card 2 specifies summary products to be printed or written to tape files, while card 3 specifies specific debugging messages that are to be printed during the conduct of the simulation. Outputs specified by these parameters are discussed in more detail in the Chapter VIII.

CARD 4: ITEM INPUT FILES

As noted above, item data is entered into INSSIM through File 07. This input may be in one of two different forms: (a) binary format or (b) free-field BCD format. Card 4 specifies which of these options is to be employed in the current simulation run. BCD format is useful for the input of manually prepared data sets for testing of new INSSIM enhancements. On the other hand, binary input is useful for

Table VII-2. Item Input Data (File 07)

<u>Variable</u>	Definition
ALC FSN	Air Logistics Center that manages this item Federal Stock Numbers, where
	<pre>FSN(1) = Material Management Code FSN(2) = Federal Stock Class FSN(3) = First six characters of the</pre>
UCOST UM NOUN MGTCD	Unit Cost of item in dollars Unit of Measure (e.g. each, feet, ounces, etc.) Item name Item management codes, where
	<pre>MGTCD(1) = Essentiality code MGTCD(2) = Supply management grouping MGTCD(3) = Weapon system code MGTCD(4) = Type computation code</pre>
IOH IOR IPPL	Initial on-hand assets (units) Initial on-order units (also know as "due-ins") Industrial Preparedness Production Leadtime
RIPPPR	Industrial Preparedness Program Ratio
IDEMND (N, J)	Number of units of demand for item N during period J
IRETUR (N, J) IREQ (N, J)	Number of serviceable returns (units) for items N in period J Number of requisitions for item N in period J

production runs involving many items and many simulation replications. Binary input is useful in the later case because it generally executes much more rapidly than jobs with BCD inputs.

Appendix A illustrates the format of INSSIM input for binary runs. For binary runs, program DATAB2 is called to reformat this data to a binary equivalent. Hence, DATAB2 serves as a preprocessor for the INSSIM MAIN program.

Figure VII-2 illustrates a sample free-field BCD input file to the model. Note the data is input in the same sequence as shown in Appendix A for binary inputs.

CARDS 5 AND 6: MANAGEMENT METHODS CARDS

Together, cards 5 and 6 specify the calcuation formulas to be used in computing inventory control levels, and specify specific parameters to be used in these calculations. Subroutines FOR576 and LEVELN perform the forecasting and inventory control levels calculations specified by these cards.

The code ICDFOR specifies the calculation to be used in computing inventory position in subroutine STATN. Possible options are defined in AFLC/XRS Working Paper No. 73, by R. J. Stevens, March 1974, and in the COMMENT Statements of STATN. To simulate current D062 calculations, set ICDFOR = 1.

Figure VII-2. Sample BCD Item Input File (File 07)

450\$:DATA:07	
460 SM 12 34 567890 123 EA 10.00 TEST- ITEM A B C D 0 0 1 1	2 2
470 3 3 3 3 6 6 6 6 350 3 6 6 3 3 6 6	UNIT DEMAND
480 1 1 1 1 1 0 0 0 0 1 1 1 1 0 0 0	RETURNS
490 1 1 1 1 2 2 2 2 1 1 2 2 1 1 2 2	REQUISITIONS
500 SM 11 55 66 77 EA 1.00 TEST2- ITEM H I J K 0 0 1 1 2 3	
510 2 2 2 2 4 4 4 4 133 1 0 0 1 1 0 0	UNIT DEMAND
520 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	RETURNS
530 1 1 1 1 2 2 2 2 1 1 0 0 1 1 0 0	REQUISITIONS
540#	112Q010111OND
55Ø\$ FND.10B	

NOTE: For this data set, these are 16 periods of demand history. Hence, to read this data, Card 4 of File 05 should set INLU = 7, INTYPE = 1, and NDEM = 16.

The code ICDSIG specifies the calculation formulas to be used in computing average annual demand rates ADR(N) and the standard deviation of demand in the lead time RSIGLT(N).

These calculations are performed by subroutine FOR576. Figure VII-3 presents the currently coded computational formulas.

At present, there are no options to these codes; the calculation specified in Figure VII-3 will always be used.

In contrast to the forecasting formulas, there are several options for EOQ and safety level calculations. These calculations are performed by subroutine LEVELN, and the codes ICDEOQ, ICDSL, and ICDSLL specify the current computational options.

Subroutine LEVELN has several distinct computational stages. The routine first computes an economic order quantity Q according to the formula specified by the code ICDEOQ. Figure VII-4 specifies the computational options. The resulting value of Q is then limited to be no less than EOQMIN months of supply and no more than EOQMAX months of supply. Further, if Q is less than 1, Q is set equal to 1.

With Q computed, LEVELN then computes the safety level, SL, according to the formula specified by the code ICDSL. Figure VII-5 specifies the current computational options. Next, the safety level SL is limited according to the computations specified by code ICDSLL. These options are

Figure VII-3. Forecast and Standard Deviation Calculation Formulas used in Subroutine FOR576.

Quarterly Demand Rate:

FORCST =
$$\sum_{n=1}^{N} \frac{(Gross Demand_n) - (serviceable returns_n)}{N}$$

where N equals the number of quarters of available data.

Annual Demand Rate:

$$ADR(N) = 4. * FORCST$$

Average Requisition Size:

REOSIZ(N) =
$$\frac{\sum_{n=1}^{N} GROSS DEMANDS_{n}}{\sum_{n=1}^{N} FREQUENCIES_{n}}$$

Quarterly MAD:

$$MAD_Q = \sum_{n=1}^{N} |Actual Quarterly Demand_n - 3 * MDR | / N$$

where N number of quarters of data

Standard Deviation of Lead Time Demand

Figure VII-4. Order Quarterly Calculation Formulas

PT:

Q = Order quarterly

RMR = Monthly demand rate (units)

ADR = Annual demand rate (units)

ADDR = Annual dollar demand rate

COSORD(I) = cost to place an order, where

I = 1 indicates small purchase and

I = 2 indicates large purchase methods

CSTBRK = Dollar breakpoint distinguishing large and small purchase methods

COSHLD = Cost to hold one dollar of stock in inventory for one year

UC = Item unit cost

The code ICDEOO specifies the following formulas.

ICDEOQ Calculation

- 1 If (ADDR ≥ \$5,000), Q = 3* RMR

 If (\$1,000 ≤ ADDR ≤ \$5,000) Q = 6* RMR

 Otherwise Q = 12* RMR
- Wilson lot size formula

Otherwise,

$$Q = \frac{2 \times COSORD(2) \times ADR}{COSHLD \times UC}$$

EOO Size Limits

For the order quantity O computed above,

if Q > EOQMAX *RMR, set Q = EOQMAX *RMR if Q < EOQMIN *RMR, set Q = EOOMIN *RMR if Q < 1, set Q = 1

Figure VII-5. Safety Level Calculation Formulas

Let SL = Safety level

RMR = Monthly demand rate (units)

RLT = Expected number of demands in a lead

REOSIZ = Average requisition size

 σ = Standard deviation of demand in the lead time

The code ICDSL specifies the following formulas.

ICDSL

Value Calculation

1 Safety Level equals one months supply

SL = 1.* R'MR

Safety level equals 1/4 of expected demand in the lead time

SL = .25 * RLT

- 3 AFLCM 57-6 formula (July 1977)
 - a) Let 7 = Average Requisition Size = REGSIZ
 - b) Compute K,

$$K = 0.707 \times LN \begin{cases} Implied \\ Shortage \\ Factor \end{cases} Unit \\ 2 \cdot Cost \cdot Cost$$

$$Z = \sqrt{2} EQQ$$

- c) Finally, SL = K * o
- 4. Presutti-Trepp formula to minimize expected units backordered.

Set 7 = 1. Then use formulas for ICDSL = 3 defined above.

5 Presutti-Trepp formula to minimize expected requisitions backordered.

Set Z = average requisition size = REQSIZ.
Then use formulas for ICDSL = 3.

described in Figure VII-6. Briefly, if ICDSLL equals 2, SL is limited to be no more than SLMIN months of supply, and no more than SLMAX months of supply. On the other hand, if ICDSLL equals 1, SL is limited to be no less than SLMIN months of supply, as before, and no more than the lesser (a) three times the standard deviation of lead time demand, or (b) the expected demand in a lead time.

Finally, the codes ICDBG and ICDSR identify calculations to be employed in setting budget guidelines in predicting future values for serviceable returns. These codes are not currently utilized in the INSSIM model.

Figure VII-6. Safety Level Limit Calculations

Let

SL = Safety level computed according to one of the formulas specified in Figure VII-5.

RMR = Monthly demand rate.

RLT = Expected demand in lead time.

SIG = Standard deviation of lead time demand.

SLMIN = Minimum safety level in months of supply.

SLMAX = Maximum safety level in months of supply.

The the code ICDSLL specifies the following limit calculations.

ICDSLL Value	Calculation .
1	If SL & SLMIN * RNR, set SL = SLMIN * RNR
	If SL> RLT, set SL = RLT
	If SL> 3* SIG, set SL = 3 * SIG
2	If SL < SLMIN * RMR, set SL = SLMIN * RMR
	IF SL > SLMAX * RMR, set SL = SLMAY * RMR

Figure VII-7. Levels Calculations Currently Coded

Given the results of the calculations defined in Figures VII-3 through VII-6, the levels for item N are computed as follows, and then rounded to the nearest integer value.

Reorder Level: IROL(N) = RLT + SL

Order Quantity: IRQT(N) = Q

Termination Level: ITL(N) = A very large number

Retention Level: IRL(N) = a very lare number

Support Level: ISUL(N) = O.

CARD 7: SYSTEM PARAMETERS

Card 7 defines cost parameters to be used in all simulation runs defined by the current set of parameter cards. The variable COSHLD defines the cost of carrying one dollars worth of stock in inventory for one year. The variable CSHORT defines a shortage cost (a Lagrange multiplier) to be used in up to four different simulation runs. Four different shortage costs must always be specified on this card. The variable COSORD (I) defines the cost of placing an order using the Ith procurement method, where I = 1 denotes small ordering methods, while I = 2 denotes the use of large purchase order methods. Finally, the variable CSTBRK denotes the cost breakpoint, that is, the dollar value of a single buy, that distinguishes between small and large purchase order methods.

CARD 8: SIMULATION SIZE PARAMETERS

This parameter card defines the size as the simulation exercize to be performed. The variable NRUN defines the specific number of simulation runs to be accomplished according to the eight parameter cards in the current set. NRUN cannot exceed four. The variable INOTR defines the number of

quarters to be simulated, while NREPL defines the number of replications of the simulation (each for INOTR quarters) to be performed by summary statistics are printed. NITEM defines the number of items to be included in a single inventory simulation replication. With present coding, NITEM should always equal 1. Finally, NDHIS defines the number of quarters of data provided as input that are to be used for initializing the INSSIM history files. At present, NDHIS should not exceed a value of 8. In addition, the total of INOTR and NDHIS cannot exceed the value of NDEM, the total number of quarters of data provided as input to the system.

Figure VII-8 illustrates the relationships among the variables NDHIS, INOTR, and NDEM. The figure illustrates the case in which there are 24 quarters of data read as input through File 97; that is, NDEM = 24. Eight of these data values are used to initialize the Item History File (NDHIS = 8). Finally, in this example the simulation proceeds for 12 quarters, beginning with the ninth quarter of data read from File 07, and ending with the 20th quarter. Data for quarters 21 through 24 are not used in this example.

This concludes our discussion of input parameters to the INSSIM model. In the next chapter, we will discuss output products produced by the simulation model.

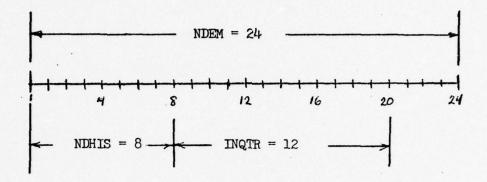


Figure VII-8. Illustration of Relationships Among Variables NDHIS, INQTR, and NDEM.

CHAPTER VIII. OUTPUT PRODUCTS

As discussed in Chapter VII, specific output products produced in a given INSSIM simulation run are specified by input parameters defined on cards 2 and 3. There are two basic categories of outputs: (a) summaries of simulation results, and (b) debugging aids. The latter category of outputs are particularly useful in the development of enhancements to the INSSIM simulation model. Let us now consider each of these types of output products in more detail.

Results Summaries

Result summary products are specified by input parameters defined on card 2. If the parameter ITWRT = 1, detailed results are written as output in binary to File 08 for each item simulated. The format of File 08 is defined in appendix D of this report. This file is particularly useful for conducting involved post-processing calculations using statistical packages such as SPSS or OMNITAB.

Another summary products are the tabular displays and graphical outputs discussed in Chapter III. These products are illustrated in Figures III-9 through III-13 and will not be discussed further here. The tabular summaries are produced when the parameter IOUT = 1, while the graphical outputs are produced when the parameter IGRAPH = 1.

In developing INSSIM enhancements, the voluminous tabular summaries and graphical outputs are usually not necessary. Consequently, another form of summary statistics has been developed; this abbreviated output is illustrated in Figure VII-1. This output product specifies key performance statistics of particular interest in most inventory simulations. This output is produced whenever the parameter IPUNCH = 1.

Let us now discuss debugging options available in the model.

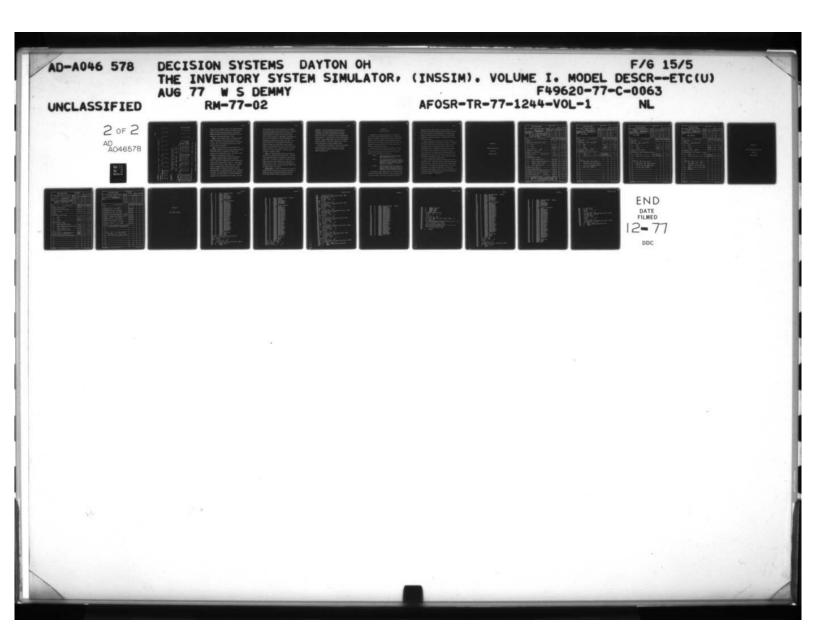
Debugging Aids

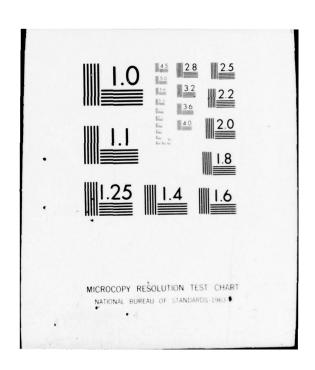
Card 3 specifies the values of five debug flags and two "trace" variables that are useful in debugging INSSIM enhancements. Let us consider the meanings of each of these input parameters.

IDBUG. If the input parameter IDBUG = 1, a message will be printed each time an event is entered or removed from the future events list. Consequently, this option will provide a listing of every event that takes place during a given INSSIM simulation run. Figure IV-1 illustrates the format and variable definitions associated with these event messages. In addition, when IDBUG = 1, stock status information is printed each time that subroutine STATN is called. The format of this output is illustrated in Figure VIII-2. As shown in the figure, this output message identifies the number of units that are on-hand,

Property Commence of the Party					J = J		ACTIONS/FSN's					Ð	V			0 11	1		Y WINTES									,	5 = 5	4	1		DOLLARS			
1444	270	259	241	264	307	264	243	262	294	284	251	236	2142	1745	n664	2107	1842	1783	1795	1677	2087	98	1715	97	0566	196	2357	3928	7679	1020	1065	2128	4125	307233	5093	633
AKBUI	277	287	268	284	324	275	258	273	314	295	290	26	80	16	30	2241	16	4997	16	85	34	90	20	236	1198	6600	2974	7208	7700	2948	9122	3178	7950	333416	8402	1625
LEETRN	22	23	22	23	20	23	21	22	20	17	20	20	-	302	B	393	131.	151	180	119	83	54	9.2	83	06	73	683	19	562	605	03	43	73	9	0	00
LBAKDT	- 7	257	430	147	0	89	123	3	5	109	-	3	~	96	9	20	2	-	0	2	C	8	55	78	4297	3797	3066	736	3188	3 4	010	534	4084	119	0037	9690
APACA		33		•	-	-	-	•	63	10	28	4	57	260	0	53	23	~	06	178	171	20	3	3	296	051	28	891	79	43	8.2	15	926	15663	833	843
ACYNA	9.6	62	53	6 1	3	1 4	42	38	47	53	53	53	0	95	7	58	73	4.5	15	7	51	35	33	7.34	6651	2584	7505	0818	4778	5305	5428	6138	9416	937639	04361	8042
	96	92	9.5	86	97	97	97	16	95	9 5	116	0	62	94	36	25	7.5	83	3.1	06	35	27	39	866	3803	51:13	5008	8448	766	8900	1851	8248	6845	1579035	5119	9587
TOUR	09	20	33	25	27	23	25	20	36	30	31	35	0	23	5	69	49	3	88	83	49	90	38	167	651	950	668	536	\$74	327	150	490	655	293786	131	77
DIK	-	7	3	t	5	9	7	80	6	10	11	12	1	2	3	2	2	9	7	80	6	30	11	12	+	2	3	t	2	9	7	00	6	40	-	12
N HER O	100	150 1	150 1	150	150	150	120 1	120 1	120	120 1	120	120	120 2			190 2	-		-							120 3		120, 3	120 3	120 3	120 3	190 3	100 3	100 3	100	120 3
SHE			27		*	*			*	34 3	3		24	*				*	3	9			7	7		7	3	*		34 3		*	3	34 3	7	,

Note: For variable definitions, see Table IV-8.





F URCST 2.8732

†IIIA

EA

1 OC 16500262550 IDENNU DEMAND/OTH

I = IEBUG = 1

IDBUG = 1

SETUR RETURN/UTR

/OTR

REO

IREO

If IFBUG = 1

695 695 669

6435 N=

1165 1916

> 100 100

FNTEP

8361

******************* **** UEMPAR--11=

**** DE MPAR--11=

**** LEMPAR--N=

LENPAR----

If IEBUG = 1

NDENIA

YEAR NO. 1

669

11

669

10

695

Figure VIII-2. Intermediate Results Output Options

***LEVELN--N=

Ľ Z

7890 4707

**** DEMPAR--11=

ENTER

FNTER

100

If HRUG = 1

**** DE MP AR -- 11= **** UF MP AR -- 11=

FATER ENTER due-in, and in a backorder status. The inventory position (INPOS) is simply equal to the sum of on-hand plus due-in assets, less any outstanding backorders. The variable REQ-SHORT identifies the number of requisitions that are backordered at that specific point in time.

IEBUG. If the parameter IEBUG = 1, subroutine INITEM writes the details of all item demand data input from File 07. The format of this output message is illustrated in Figure III-2, and corresponds exactly with the data layout specified in appendix A.

IFBUG. The IFBUG parameter causes the printing of forecasting information, as well as the printing of demands, serviceable returns, and requisition frequency data recorded in the current history file. The format of this information is illustrated in Figure VII-2.

IGBUG. The IGBUG parameter causes the printing of requisition generation events created by subroutine DEMPAR. Figure VII-2 illustrates a specific printout that occurred when the flags IDBUG = IGBUG = 1. Note from the figure that at time 100, a type 12 event (i.e., a DEMPAR event) is removed from the future events list. When subroutine DEMPAR is called, the associated number of demands (IDEMMD) to be generated is nine, as is circled in the figure. The requisition generation process discussed in Chapter VI is then initiated. The first requisition generated is for a requisition size of 2 units. Note that

this requisition for two units (event code 1) is entered on the future events list to occur at time 6435. Note that the second requisition is for one unit, and that this second requisition is entered onto the future events list to occur at time 8361. Subsequently, requisitions for two, one, one, and finally two units are generated in succession and placed onto the future events list. Note that the total of all of these generated requisitions equals nine units, the total number of units that were present in the demands history record for the current item. Finally, note that a type 12 event is placed on the future events list to occur at time 8500. This will cause the next CALL to subroutine DEMPAR.

IHBUG. The IHBUG parameter specifies the printing of levels that are computed by subroutine LEVELN. The format of the associated printout is illustrated at the bottom of Figure VII-2. As shown in the figure, the levels for item number 1 involve an order quantity of 14 units, and a reorder level of 7 units. For this item, termination and retention levels are set to very large numbers (99999), and the support level is set to zero.

ITRACE, ISTRAC. At times, the analyst will not want to produce the many lines of print that result when IDBUG = 1, although he may be interested in obtaining an event by event printout during a specific time interval in the

simulation. The flags ITRACE and ISTRAC provide this capability. The variable ITRACE specifies the point in simulated time that a detailed trace of simulation events is to start. At that point in time, the flag IDBUG is set equal to 1. This causes the event by event printout to start. The flag remains equal to 1 until the simulated clock time ISTRAC. At this time, IDBUG is reset to zero, and the detailed event by event printouts cease.

This concludes our discussion of INSSIM output products.

In the next chapter, we will discuss the job control language statements required to assemble and execute INSSIM simulation runs.

CHAPTER IX

JOB CONTROL CARDS

a set of Job Control Language statement cards. These cards cause the appropriate subroutines to be acquired from CREATE permanent files and assembled into an executable package. These routines also assure that input files are read from the appropriate physical devices, and that output products are directed to appropriate locations.

We have found there are three basic job streams that are useful in the conduct of an INSSIN simulation study. These job streams are documented in Appendix C of this volume. Briefly, these job streams are as follows:

- INSSIM.T This job stream is used for testing of INSSIM enhancements, and for debugging newly developed subroutines.
- INSSIM.A This job stream provides for the printing of all INSSIM input data, and produces tabular summaries of simulation performance statistics. Graphical displays of these statistics as a function of simulated time are also produced.
- INSSIM.B This job stream is used for performing several simulation runs at a single time. The job stream is particularly useful in developing cost effectivenesss curves for alternate inventory management policies.

In performing a given INSSIM.T study, it is usually useful to begin with the INSSIM.T job stream. This job stream would be used for testing of new code that defines forecasting or inventory control policies that are to be evaluated. In this stage, the detailed debugging statements defines on input card 4 will probably be used extensively. The INSSIM.T job stream will usually utilize File 07 input data in free-field BCD format. No pre-processing step is necessary when data is input in this form.

Once new calculation formulas have been fully debugged, the INSSIM.A and INSSIM.B job streams are employed. The INSSIM.A job stream is useful for initial testing of data to be used in production runs. The graphical outputs of INSSIM.A are particularly useful in determining whether there are "weird" data elements that are included in the proposed data set.

Once a data set has been identified that appears suitable for simulation study, the INSSIM.B job stream is utilized. This job stream is designed to provide a large number of simulation runs at the lowest possible computer cost.

Both the INSSIM.A and INSSIM.B job streams utilize a preprocessing step. In these job streams, subroutine DATAB2 reads
input from File 07, and writes the same data in binary format
to File 09. This latter file then becomes input to the INSSIM
MAIN program. In performing production runs, there will
usually be a large amount of data to be read in through File 07.
By converting this information to binary, the data processing
steps may be speeded up considerably.

APPENDIX A.

INSSIM ITEM DATA FILE

(FILE Ø7)

RECORD LAYOUTS

	INPUT /OUTPUT RECORD		SYSTE	M NUMBER	PAG	E / OF	4 PAGE
TITLE	INSSIM ITEM DATA RECORD (RECORD TYPE = 1)	INPUT / OUTPUT	FILE	NUMBER	RUN NUMBER	SEQUENC	E OF FILE
DATA I	RECORD LENGTH TAPE RECORD LENGTH/	1	. 4				
REMAR							
NO.	DATA ELEMENT NAME			FORTRAN VARIABLE	POSITION OR BLOCK	STRUC	CHARAG
1	ALC			ALC	1	2	AN
2	FEDERAL STOCK MMBER (FSN)						
	ММС			FSN(1)	2	2	AN
	FSC			FSN(2)	3	4	AN
	NIIN			FSN(3) & FSN(4)	2	3	AN
3	RECORD TYPE = 1			IR	6	1	N
4	UNIT OF MEASURE			UM	7	2	AN
5	UNIT PRICE (FORMAT F	9.2)		UCOST	8	9	N
6	Noun			NOUN	9	10	AN
7	PROCESSING CODES						
	ITEM ESSENTIALITY			MGTCDLI)	11	1	N
	SUPPLY MANAGEMENT GROW	PING		MGTCD(2)	12	1	AN
	WEAPON SYSTEM CODE			метеріз)	13	4	AN
	TYPE COMPUTATION			MGTCD(4)	14	2	AN
8	ON- HAND ASSETS			IOH	15	7	N
9	ON - ORDER ASSETS			IOR	16	7	AN
10	ADMINISTRATIVE LEAD TIME (MO	NTHS)		LTADM	17	2	N
11	PRODUCTION LEAD TIME (MONTH	45)		LTPROD	18	2	N
12	IPP LEAD TIME (MONT	45)		IPPL	19	2	N
13	IPP PROGRAM RATIO	F4.2)	RIPPPR	20	4	N
	NO 3 (RECORD TYPE)						

INPUT /OUTPUT RECORD		SYSTEM NUMBER	PAG	E 2 OF	4	
TITLE INSSIM DEMAND RECORD (RECORD TYPE = 2)	INPUT / OUTPUT	FILE NUMBER	RUN NUMBER	SEQUENCE OF FILE		
DATA RECORD LENGTH TAPE RECORD LENGTH/ BLOCKING FACTOR		Ψ1				
SEE BELOW						
		FORTRAIN	POSITION	STRUG	TURE	
NO. DATA ELEMENT NAMI	E	VARIABLE	BLOCK	LENGTH		
I ALC **		ALC		2	AN	
2 FEDERAL STOCK NUMBER **						
MMC		FSN(1)	2	2	AN	
FSC		FSN(2)	3	4	AN	
NIIN		e fsn(3)	45	9	AN	
3 RECORD TYPE = 2 **		IR	6	1	N	
4 TRANSFER + SALES DEMAND						
QTR 1		IT) IDEMND(N, 1)	7	7	N	
QTRS 2, 3,, THRU					N	
FOR SCD INPUT, DATA	15					
FREE-FIELD, AND DATA EL						
1, 2, AND 3 ARE NOT TO						
THE INPUT STREAM.	QC 7/V.					

	INPUT /OUTPUT RECORD		SYST	EM NUMBER	PAG	E 3 OF	4 PAGE	
TITLE	INSSIM SERVICEABLE RETURNS INPUT / OUTPUT FILE NUMBER RECORD (RECORD TYPE = 3)			RUN NUMBER	SEQUENCE OF FILE			
	RECORD LENGTH TAPE RECORD LENGTH	I		97				
REMARI	SEE BELOW			•				
NO.	DATA ELEMENT N	AME				STRUC	RUCTURE	
1	ALC **			ALC	BLOCK	2	AN	
2	FEDERAL STOCK NUMBER						.,,,,	
•	MMC			FSN(1)	3	2	AN	
	FSC			FSN(2)	3	4	AN	
	NIIN			FSN(3)2 FSN(4)	4 5	9	AN	
3	RECORD TYPE = 3 **			IR	6	1	N	
4	TRANSFER + SALES SERVICER	ABLE RETUR	ens					
•	OTR 1		(7	IRETUR(N,1)	7	7	N	
,	QTRS 2, 3,, THRU 2			J=2,,24			N	
	FOR BCD INPUT, DA							
				1				
	FREE-FIELD, AND DA					-		
	1, 2, AND 3 ARE NO	OF TO BE		1				
	IN THE INPUT STREAM	м.						
				•				
				1				
				1				

	INPUT /OUTPUT RECORD		SYST	EM NUMBER	PAG	E 4 OF	4 PAGES
TITLE	INSSIM REQUISITION FREQUENCY RECORD (RECORD TYPE = 4)	INPUT /	FIL	FILE NIIMBED		RUN SEQUENCE OF	
	GINARY WORDS	I	Ø7				
REMARK	KS .						
	SEE BELOW						
NO.	DATA ELEMENT NAME			FORTRAN VARIABLE	POSITION OR BLOCK	STRUC LENGTH	TURE
1	ALC **			ALC	1	2	AN
2	FEDERAL STOCK NUMBER						
	ММС			FSN(1)	2	2	AN
	FSC			PSN(2)	3	4	AN
	NIIN			8 FSN(4)	75	9	AN
3	RECORD TYPE = 4 **			IR	6	i	N
4	FREQUENCY OF DEMANDS BY	YOTR					
	QTR 1	(1	7)	DREQ(N,1)	7	7	N
	QTRS 2, 3,, THRU 24	(23:	7)	IREQ(N, J), J=2,,,,24	8 THRU 30	161	~
	AN FOR BCD MOUT, DATA	is			•		
	FREE-FIELD, AND DATA		*				
	ELEMENTS 1, 2, AND 3	ARE					
	NOT TO BE IN THE I	NPUT	<u> </u>				
	STREAM.						

APPENDIX B.

INSSIM SIMULATION RESULTS FILE

(FILE Ø8)

RECORD LAYOUTS

				INSSIM		PAGE 1 OF 2 PAGE		
TITLE	SIMULATION RESULTS	RECORD	INPUT / OUTPUT	FILE NIMBED			RUN SEQUENCE OF	
DATA I	RECORD LENGTH TAPE RECORD BLOCKING FA	D LENGTH/	0		φ8			
REMAR	ALL INSSIM INTEGER VARIABLE CONVERTED TO FLOATING AND OUTPUT IN BINARY F	POINT VARIABLES						
NO.	DATA E	LEMENT NAME			FORTRAN VARIAGLE	POSITION OR BLOCK	STRUCTURE LENGTH CHARA	
1	RUN IDENTIFICATION				IDENT	I I	4	N
2	SAFETY LEVEL FORMULA	Code			ICD2r	2	1	N
3	RUN NUMBER				MRUN	3	1	N
4	ALC		•		ALS	4	2	AN
5	FEDERAL STOCK NUMB	FR						
	MMC				FSN(1)	5	2	AN
	FSC				FSN(2)	6	4	AN
	NIIN				FSN(3)	7 8	3	AW
6	MANAGEMENT CODES							
	ITEM ESSENTIALI	TY CODE			MGTCD(1)	9	1	N
	SUPPLY MANAGEM	ENT GROUPIN	UG C	360	MGTCD(2)	10	1	AN
	WEAPON SYSTEM	Cope			MGTCD(3)	.11	4	AN
	TYPE COMPUTATI	ON CODE			MGTCD(4)	12	2	AN
7	UNIT PRICE	INISTRATIVE LT	,		UCOST(1)	13	9	F9.2
8	TOTAL LEAD TIME (+PROD	UCTION LT	/		LTPRODLI) IOH+IOR	14	7	~
9	INITIAL ON-HAND + DUE-IN	INVENTORY (UNITS)		15HT10K	15	7	~

INPUT /OUTPUT RECORD			INSSIM	PAG	PAGE 2 OF 2 PAGE		
TITLE	SIMULATION RESULTS RECORD	FILE NUMBER	RUN NUMBER	SEQUENCE OF EIL			
DATA R	ECORD LENGTH TAPE RECORD LENGTH/ BLOCKING FACTOR						
REMARK	s						
NO.	DATA ELEMENT NAME		FORTRAN VARIABLE	POSITION OR BLOCK	STRUC	CHARA	
10	REMUCITIONS AN ATA		IREQT(I)				
	REQUISITIONS BY OTR DEMAND (UNITS) BY OTR		IREQT(I, 2)				
12	RETURNS (UNITS) BY GTR		TRETRU(I,2)				
	REQUISITION BACKORDER-WEEKS	BY QI	*				
14	UNIT BACKORDER-WEEKS BY						
15	BUY - UNITS BY OTR		LORDER(I,2)				
16	INVENTORY UNIT-WEEKS BY GIR		INVDAY(I,2)				
17	FILLS REQUISITIONS BY QTR		IFILLT(I,I)				
18	FILLS BY OTR		IFILLT (I,2)				
19	TOTAL COST OF ORDERING in \$ - = COSORD(1) # ISMORD(I,1) + COSORD(2) #	ILGORDI.	FJI)				
	FOR QTRS 1, 2,, THRU INC	QTR,					
	THE NUMBER OF SIMULATED		2				
			•				
					-	-	
			,				

APPENDIX C.

JOB CONTROL PROGRAMS

```
INSSIM. A
                          WP1279.XRS/DEMMY
22
         $
                 IDENT
         $
30
                 USERID
                          REQSSIZE
                          Ø5,,,5K
FORTRAN, NOMAP
         $
35
                LIMITS
         $
40
                 OPTION
         $
50
                 SELECT
                          REQS/DATAB2.0
55
         $
                 SELECT
                          REQS/DEMPAR.O
         $
56
                 SELECT
                          REQS/RANDU.O
         $
                 EXECUTE
60
         $
70
                 PRMFL
                          Ø7,R,S,REQS/SIM.DI
80
         $
                FILE
                          Ø9,XIS
         $
85
                 OPTION
                          FORTRAN, NOMAP
         $
90
                 SELECT
                          REQS/MAIN. O
100
                 SELECT
                          REQS/STATUS.O
         $
                 SELECT
                          REQS/DEMPAR.O
110
         $
                          REQS/ENTERB. 0
120
                 SELECT
         $
                 SELECT
                          REQS/FILLBO.O
130
         $
                 SELECT
                          REQS/FOR576.0
140
         $
                 SELECT
                          REQS/FORUPD.O
150
160
                 SELECT
                          REQS/INITAL.O
170
                 SELECT
                          REQS/INITEM. O
         $
                 SELECT
                          REQS/LEVEL.O
180
         $
                          REQS/LEVELN.O
190
                 SELECT
         $
                          REQS/ORDER. O
200
                 SELECT
         $
                          REQS/OUTCST. 0
210
                 SELECT
         $
                          REQS/RECEIV. O
220
                 SELECT
239
                 SELECT
                          REQS/RET.O
         $
                SELECT
                         REQS/ZERO.O
240
         $
250
                 SELECT
                          REQS/ENTER. O
         $
260
                 SELECT
                          REQS/SSTAT.O
         $
270
                 SELECT
                          REQS/OUT. 0
         $
280
                 SELECT
                          REQS/REQ. 0
290
         $
                 SELECT
                          REQS/REMOVE.O
         $
300
                 SELECT
                          REQS/WRIFEL.O
310
                 SELECT
                         REQS/STATN. 0
         $
320
                 SELECT
                          REQS/CUM.O
         $
330
                          REQS/CUMB. 0
                 SELECT
         $
340
                 SELECT
                          REQS/INFEL.O
         $
                 SELECT
350
                          REQS/ITRSLT. 0
360
         $
                 SELECT
                          REQS/RANDU.O
         $
370
                 SELECT
                          REOS/PLOTR.O
380
                 SELECT
                          REQS/GP. 0
390
                 EXECUTE
         $
                          Ø5,3ØK,,1ØK
400
                 LIMITS
         $
410
                 REMOTE
                          P*,AC
        . $
                REMOTE
                          $$, AC
420
430
                          05
                 DATA
              "100 ITEM SIMULATION WITH ZERO SS"
440
450 4 P
          0 1 1 1
                      C2
          01000
                                 C3
          7 2 24
470
4800
                               C5
          1123111
                        Ø.
                    Ø.
493
              36.
                               C6
           .20
500
                10. 31.6 100. 316. 269.87 460.27
                                                       10000.
510
                  100 1 8
              12
                                  CS
                          07, X1R
520
                 FILE
                 ENDJOB
530
```

```
WP1279 XRS/DEMMY
                                                  INSSIM.B
20
                 IDENT
                          REQS$IZE
30
         $
                 USERID
                          50...10K
FORTRAN, NOMAP
40
         $
                 LIMITS
         $
50
                 OPTION
         $
                          REQS/DATAB2.0
60
                 SELECT
70
         $
                 SELECT
                          REQS/DEMPAR. 0
80
         $
                          REQS/RANDU.O
                 SELECT
         $
90
                 EXECUTE
                          07,R,S,REQS/SIM.DI
100
                 PRMFL
         $
                          09.XIS
110
                 FILE
120
         $
                 NCITAO
                          FORTRAN, NOMAP
130
         $
                 SELECT
                          REQS/MAIN.O
140
         $
                 SELECT
                          REQS/STATUS.O
150
         $
                 SELECT
                          REQS/DEMPAR.O
160
         $
                 SELECT
                          REQS/ENTERB.O
170
         $
                 SELECT
                          REGS/FILLBO.O
         $
130
                 SELECT
                          REQS/FOR576.0
190
         $
                 SELECT
                          REQS/FORUPD.O
         $
200
                 SELECT
                          REQS/INITAL.O
         $
210
                 SELECT
                          REQS/INITEM.O
         $
220
                 SELECT
                          REQS/LEVEL. 0
         $
230
                 SELECT
                          REQS/LEVELN. O
         $
240
                 SELECT
                          REQS/ORDER.O
         $
250
                 SELECT
                          REQS/OUTCST. 0
         $
260
                 SELECT
                          REQS/RECEIV.O
                 SELECT
270
         $
                          REQS/RET. 0
280
         $
                 SELECT
                          REQS/ZERO. 0
290
         $
                 SELECT
                          REQS/ENTER.O
         $
300
                 SELECT
                          REQS/SSTAT. 0
         $
                 SELECT
310
                          REQS/OUT.O
         $
320
                 SELECT
                          REQS/REQ. 0
         $
                          REQS/REMOVE. 0
330
                 SELECT
         $
340
                 SELECT
                          REQS/WRIFEL.O
         $
350
                 SELECT
                          REQS/STATN.O
         $
360
                 SELECT
                          REQS/CUM. O
         $
                          REQS/CUMB. 0
37Ø
                 SELECT
         $
380
                 SELECT
                          REQS/INFEL.O
         $
390
                 SELECT
                          REQS/ITRSLT.O
400
         $
                 SELECT
                          REQS/RANDU.O
         $
                 SELECT
                          REQS/PLOTR.O
410
         $
                          REQS/GP.O
420
                 SELECT
         $
430
                 EXECUTE
         $
440
                 LIMITS
                          50,30K,.10K
         $
450
                          P*, AC
                 REMOTE
         $
460
                 REMOTE
                          $$, AC
470
                          05
                 DATA
           22
                 100 ITEMS
480
                        C2
490
          1 1
              Ø
                 0
    DATA
                                  C3
500
            0 0 0
                         Ø
                           Ø
          Ø
     SET
          7
            2
510
              24
    #1
            123111
                                C5
520
```

```
530
         6. 36. Ø. Ø. C6
          .20 10. 31.6 100. 316. 269.87 460.27 10000.
540
         1 12 100 1 8 C8
23 100 ITEMS --- C8
550
560
         1 1 0 0 C2
570
         00000
                      ØØ
580
590 DATA
         7 2 24
                            C5
600 SET
         1123111
         6. 36. Ø. 40. C6
610 #2
          .20 10. 31.6 100. 316. 269.87 460.27 10000.
620
         4 12 100 1 8 C8
33 100 FTEMS --- C8
630
640
                    C2
650
         1100
660
         00000
                     0 0
                               C3
670 DATA
         7 2 24
680 SET
         1 1 2 3 1 1 1 C5
6. 36. 0. 40. C6
.20 600. 1000. 3162. 10000. 269.87 460.27 10000.
690 IF
700 3
         4 12 100 1 8
710
          24 100 ITEMS ---
720
730
         1 1 Ø Ø C2
740 DATA
         00000
                      ØØ
         7 2 24
750
760 SET
         1 1 2 4 1 1 1 C5
6. 36. Ø. 40. C6
770 #
          .20 10. 31.6 100. 316. 269.87 460.27 10000.
78Ø
         4 12 100 1 8 · C8
790_
          34 100 ITEMS --
800
         1100
                   C2
810
820 DATA
                   0 0
         00000
         7 2 24
830
840 SET
         1124111
850 ± 5
         6. 36. Ø. 4Ø. C6
          .20 600. 1000. 3162. 10000. 269.87 460.27 10000.
         4 12 130 1 8 C8
25 100 ITEMS --- C8
870_
880
                    C2
         1100
890
         00000
                               C3
                     ØØ
900
910 DATA 7 2 24
        1 1 2 5 1 1 1 C5
6. 36. Ø. 4Ø. C6
920 SET
930
     İ
          .20 10. 31.6 100. 316. 269.87 460.27 10000.
940
         4 12 100 1 8
950
              100 ITEMS ---
          35
960
         1 1 Ø Ø C2
 970
         0 0 0 0 0
7 2 24
                               C3
DATA DEE
                      ØØ
                          C5
C6
 1000 Set 1 1 2 5 1 1 1
        6. 36. 0. 40. C6
.20 600. 1000. 3162. 12000. 269.87 460.27 10000.
 1013 #
1020
         4 12 100 1 8
 1030_
                       Ø7.XIR
        $ FILE
 1040
                      08, X2D, ,75985, ,SMRSLTS/RING
               TAPE
 1050
        $
              ENDJOB
 1060
```

	20	\$	IDENT	WP1279, XRS/DEMMY	INSSIM.T
	30	\$	USERID	REQS\$IZE	
	40	\$	OPTION	FORTRAN, NOMAP	
	50	\$	SELECT	REQS/MAIN.O	
	60	\$	SELECT	REQS/STATUS.O	
	7Ø	\$	SELECT	REQS/DEMPAR.O	
	80	\$		REQS/ENTERB. 0	
	90	\$	SELECT	REQS/FILLBO.O .	
	100	\$.	SELECT	REQS/FOR576.0	
	110	\$	SELECT	REQS/FORUPD.O	
	120	\$	SELECT	REQS/INITAL.O	
	130	\$	SELECT	REQS/INITEM. O	
	140	\$	SELECT	REQS/LEVEL.O	
	150	\$	SELECT	REQS/LEVELN.O	
	160	\$	SELECT	REQS/ORDER. O	
•	179	\$	SELECT	REQS/OUTCST. 0	
	180	\$	SELECT	REQS/RECEIV.O	
	190	\$	SELECT	REQS/RET.O	
	200	\$	SELECT	REQS/ZERO.O	
	210	\$	SELECT	REQS/ENTER. O	
	220	\$	SELECT	REQS/SSTAT.O	
	230	\$	SELECT	REQS/OUT. 0	
	240	\$	SELECT	REQS/REQ.O	
	250	\$	SELECT	REQS/REMOVE.O	
	260	\$	SELECT	REQS/WRIFEL.O	
	270	\$	SELECT	REQS/STATN.O	
	280	\$	SELECT	REQS/CUM.O	
	290	\$	SELECT	REQS/CUMB.O	
	300	\$	SELECT	REQS/INFEL.O	
	305	***********************	SELECT	REQS/ITRSLT.O	
	306	\$	SELECT	REQS/RANDU.O	
	310	\$	EXECUTE		

```
320
                    10,25K,,5K
             LIMITS
       $
330
             REMOTE
                    Ø9, AC
340
       $
             REMOTE
                   P*, AC
       $
350
             REMOTE
                    $$,AC
360
       $
                    05
             DA TA
         INSSIM.T DEMPAR TEST RUN
370
380
        0001
                  C2
39Ø
        11010
                  0
                             C3
400
        7 1 16
        1123111
410
                        C5
420
        6. 36. 0. 40.
                        C6
430
        .20 10. 50. 100. 400. 269.87 460.27
                                           10000.
                                                    C7
448
        12118
                   C8
450
             DATA
                    07
460
       SM 12 34 567890 123 EA 10.00 TEST- ITEM A B C D 0 0 1 1 2 2
        3 3 3 3 6 6 6 6 350 3 6 6 3 3 6 6
470 .
480
        111110000 1111000
        1111222211221122
490
500
       SM 11 55 66 77 EA 1.00 TEST2- ITEM H I J K Ø Ø 1 1 2 3
510
       222244441331001100
520
       00000000000000000
53Ø
       111122221100 1100
540
550
      $
             ENDJOB
```

```
20
         $
                 IDENT
                          WP1279, XRS/DEMMY
                                                 INSSIM.C
         $
                          REQS$ IZE
30
                 USERID
         $
40
                 LIMITS
                          Ø6,,,10X
         $
50
                . OPTION
                          FORTRAN NOMAP
         $
55
                 SELECT
                          REQS/DEMPAR.O
         $
56
                 SELECT
                          REQS/RANDU.O
         $
                          REQS/DATAB2.0
60
                 SELECT
         $
                 EXECUTE
70
         $
                          Ø7,R,S,REQS/SIM.DI
80
                 PRMFL
         $
                          Ø9.XIS
90
                 FILE
         $
100
                 OPTION
                          FORTRAN, NOMAP
         $
110
                 SELECT
                          REQS/MAIN.O
         $
120
                          REQS/STATUS. 0
                 SELECT
         $
130
                 SELECT
                          REQS/DEMPAR. O
         $
140
                 SELECT
                          REQS/ENTERB. 0
         $
150
                 SELECT
                          REQS/FILLBO. 0
         $
                          REOS/FOR576.0
160
                 SELECT
         $
170
                 SELECT
                          REQS/FORUPD. 0
         $
180
                 SELECT
                          REQS/INITAL.O
         $
                 SELECT
190
                          REQS/INITEM.O
         $
200
                 SELECT
                          REQS/LEVEL.O
         $
210
                 SELECT
                          REQS/LEVELN.O
         $
220
                 SELECT
                          REQS/ORDER.O
         $
230
                 SELECT
                          REQS/OUTCST.O
         $
240
                 SELECT
                          REQS/RECEIV. O
         $
250
                 SELECT
                          REQS/RET.O
         $
260
                 SELECT
                          REQS/ZERO. 0
         $
270
                 SELECT
                          REQS/ENTER. O
         $
280
                 SELECT
                          REQS/SSTAT.0
         $
290
                 SELECT
                          REQS/OUT.O
         $
                 SELECT
                          REQS/REQ. 0
300
         $
                 SELECT
                          REQS/REMOVE.O
310
         $
                 SELECT
                          REQS/WRIFEL.O
320
         $
330
                 SELECT
                          REQS/STATN.O
         $
340
                 SELECT
                          REQS/CUM.O
         $
350
                 SELECT
                          REQS/CUMB.O
         $
360
                 SELECT
                          REQS/INFEL.O
         $
370
                 SELECT
                          REQS/ITRSLT.O
         $
                 SELECT
380
                          REQS/RANDU.O
         $
                          REGS/PLOTR. 0
390
                 SELECT
         $
                 SELECT
                          REQS/GP. 0
400
         $
                 EXECUTE
410
         $
420
                 LIMITS
                          Ø6,3ØK,,1ØK
         $
430
                 REMOTE
                          P* . AC
         $
                          $$, AC
440
                 REMOTE
         $
450
                 DATA
                          05
                 100 ITEMS
460
           41
          Ø1
               ØØ
                         C2
470
                                  C3
          00000
                         0 0
480
          7 2 24
490
                                C5
500
          1 1 2
                5 1 1 1
                          40.
                     Ø.
51 Ø
           6.
                36.
          .20 1000. 31.6 100. 316.
                                        269.87 460.27 10000.
520
530
          1 12 100 1 8
                                 C8
         $
                          Ø7,XIR
540
                 FILE
         $
                 ENDJ OB
550
```

```
20
                 IDENT
                          WP1279, XRS/DEMMY
                                                 INSSIM.D
30
         $
                 USERID
                          REQS$IZE
         $
                 LIMITS
40
                          25,,,10K
         $
50
                 OPTION
                          FORTRAN, NOMAP
60
                 SELECT
                          REQS/DATAB2.0
         $
70
                 SELECT
                          REQS/DEMPAR.O
         $
                          REQS/RANDU.O
80
                 SELECT
         $
90
                 EXECUTE
         $
100
                 TAPE
                          Ø7, X3D, ,71515, ,SIM.D2
         $
                          09. XIS
110
                 FILE
         $
120
                 OPTION
                          FORTRAN, NOMAP
         $
                 SELECT
                          REQS/MAIN.O
130
140
         $
                 SELECT
                          REQS/STATUS. 0
         $
                 SELECT
                          REQS/DEMPAR. O
150
         $
                 SELECT
160
                          REQS/ENTERB. 0
         $
170
                 SELECT
                          REQS/FILLBO.O
         $
180
                 SELECT
                          REQS/FOR576.0
         $
193
                 SELECT
                          REQS/FORUPD.O
200
                 SELECT
                          REQS/INITAL.O
         $
                 SELECT
210
                          REQS/INITEM. O
         $
220
                 SELECT
                          REQS/LEVEL.O
         $
230
                 SELECT
                          REQS/LEVELN.O
         $
240
                 SELECT
                          REQS/ORDER. O
250
                 SELECT
                          REQS/OUTCST. 0
         $
260
                 SELECT
                          REQS/RECEIV. 0
270
         $
                 SELECT
                          REQS/RET.O
         $
280
                 SELECT
                          REQS/ZERO. 0
         $
290
                 SELECT
                          REQS/ENTER. O
         $
300
                 SELECT
                          REQS/SSTAT.0
         $
310
                 SELECT
                          REQS/OUT. 0
320
                 SELECT
                          REQS/REQ. 0
330
                 SELECT
                          REQS/REMOVE.O
340
                 SELECT
                          REQS/WRIFEL.O
         $
350
                 SELECT
                          REQS/STATN.O
         $
360
                 SELECT
                          REQS/CUM.O
370
         $
                 SELECT
                          REQS/CUMB. 0
         $
380
                 SELECT
                          REQS/INFEL.O
390
                 SELECT
                          REQS/ITRSLT.O
         $
400
                 SELECT
                          REQS/RANDU.O
410
                 SELECT
                          REQS/PLOTR.O
                 SELECT
                          REQS/GP. 0
420
         $
430
                 EXECUTE
                 LIMITS
                          50,30K,,10K
440
                 REMOTE
                          P*, AC
450
                 REMOTE
                          $$,AC
460
470
                DATA
                          Ø5
```

```
33 100 ITEMS --
480
                         C2
490
          1100
                         0 0
                                   C3
500
          00000
          7 2 24
510
          1 1 2 3 1 1 1 C5
6. 36. Ø. 4Ø. C6
.2Ø 6Ø0. 1ØØ0. 3162. 1ØØ00. 269.87 460.27 10000.
520
530
540
          4 12 100 1 8
550
           34 100 ITEMS -
560
          1100
                        C2
570
                                   C3
          00000
                         0 0
580
          7 2 24
590
          1 1 2 4 1 1 1 . C5
6. 36. 0. 40. C6
.20 600. 1000. 3162. 10000. 269.87 460.27 10000.
600
61 Ø
620
          4 12 100 1 8
                                  C8 4
630
                         07, XIR
                 FILE
640
                          Ø8. X2D., 732Ø5, ,RSL.II/RING
         $
                 TAPE
650
         $
                 ENDJOB
660
```